AD-A078 028 NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER SAN D--ETC F/G 5/9
FORECASTING NAVAL ENLISTED OCCUPATIONAL RETENTION BEHAVIOR UNDE--ETC(U)
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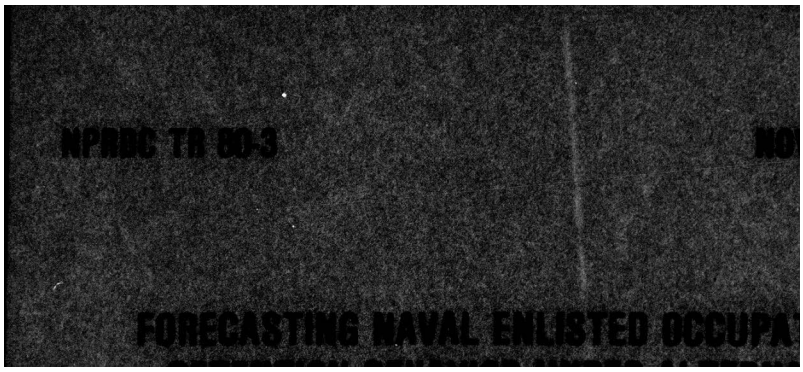
NPRDC TR 80-3
FORECASTING NAVAL ENLISTED OCCUPA

(14) NPRDC-TR-80-3

(11) November 1979

(6) FORECASTING NAVAL ENLISTED OCCUPATIONAL RETENTION BEHAVIOR UNDER ALTERNATIVE RETIREMENT SYSTEMS.

(12) 60

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NPRDC TR 80-3	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FORECASTING NAVAL ENLISTED OCCUPATIONAL RETENTION BEHAVIOR UNDER ALTERNATIVE RETIREMENT SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED Final August 1978 - January 1979 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Mark D. Chipman Hans Mumm		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62763N ZF55.521.010
11. CONTROLLING OFFICE NAME AND ADDRESS Navy Personnel Research and Development Center San Diego, California 92152		12. REPORT DATE November 1979 13. NUMBER OF PAGES 60
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Retirement policy
Personnel force management
Enlisted retention
Manpower planning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Recently, substantial changes in the U.S. military retirement system have been proposed by various groups. While the primary goal is the reduction of total personnel costs (particularly retirement costs), a significant consideration is the resulting change in retention behavior of active duty personnel. For the Navy enlisted force, which already faces retention problems in some high technology ratings, the implementation of a new retirement system without considering its effect on occupational retention behavior could easily lead to personnel shortages and quality reductions in the force.

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A previously developed technique is used to derive forecasting functions for 15 enlisted rating groups characterized by relatively homogeneous occupations and retention behavior. Examples of forecasted retention rates and continuation rates under two different retirement systems are given. In addition, applications of the forecasting function to selective reenlistment bonus policies are presented.

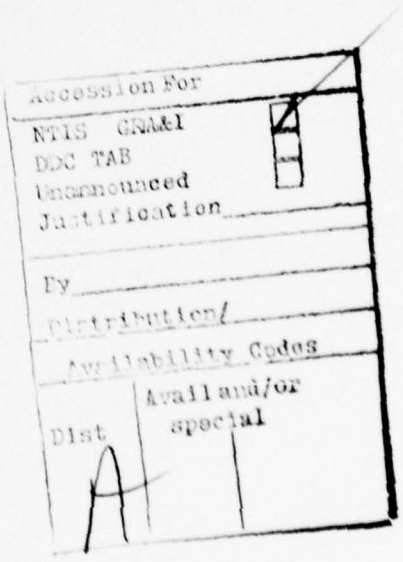
FOREWORD

The effort described in this report supports the development of compensation and cost models, an exploratory development objective under Task Area ZF55.521.010. The objective of this task area is to develop techniques to improve the Navy's managerial decision-making capabilities in the areas of manpower and personnel. The main effort in FY79 focused on the cost and force behavior implications of alternative retirement policies. This problem has been addressed, in part, by investigating the enlisted occupational implications of those policies. The model documented in this report, intended for use by OP-134 (Compensation and Entitlements Branch), allows the retention effects of an alternative retirement system on the enlisted occupational communities to be determined.

This report is the fourth in a series documenting work in the area of retirement analysis. The first two, NPRDC TN 78-8 and NPRDC TR 78-29, described the development of the Retirement Analysis Model I (RAM I), a costing model. The third, NPRDC TR 79-4, documented RAM II, a model that forecasts enlisted retention and continuation rates under alternative retirement systems. A subsequent report will deal with a mathematical comparison of all the enlisted retention forecasting models known to exist.

Acknowledgments are due Dr. R. J. Niehaus and B. C. Hall of the Office of Civilian Personnel for providing civilian occupational data.

DONALD F. PARKER
Commanding Officer



SUMMARY

Problem

Navy planning and policy decisions often address problems where there are multiple, conflicting objectives. One such problem involves the evaluation of alternative military retirement policies. A retirement policy affects not only personnel costs but also the composition of the enlisted force. To aid in the development of an effective retirement policy, models have been developed to forecast the continuation behavior of enlisted personnel occupational groups, given an underlying set of assumptions.

Objective

The objective of this effort is to extend previously developed retirement analysis techniques to occupational groups of personnel. These methods could be used to assess the effects of a particular retirement system on the continuation behavior of one or more groups of enlisted ratings.

Approach

The Navy enlisted force was divided into 15 groups of ratings characterized by relatively homogeneous occupations and retention behavior. A dynamic programming model was used to compute, for each occupational group, the present discounted value of remaining in the military as opposed to retiring or leaving for civilian employment prior to retirement. Civilian opportunities based on the occupational categories were identified separately for each group. By analyzing the relationship between the cost of leaving military service and retention rates, by pay grade and length of service (LOS), forecasting models involving the use of a logit function were developed for the 15 groups to yield retention rates given the economic incentives of any retirement policy. By combining the forecasted retention rates with the current continuation rates for those personnel continuing in service, occupational group LOS continuation rates can be predicted.

Results

The models described in this report represent the fourth step in the development of more advanced tools to assess the effects of proposed alternative retirement systems. (The previous steps were documented in Chipman & Silverman, 1978; Chipman, Silverman, & Willis, 1978; and Chipman & Mumm, 1978.) The analytical methods developed in the fourth step were made operational in an interactive computer model. This model, called Retirement Analysis Model III (RAM III), is designed to forecast voluntary retention rates by pay grade and LOS, using three different logit functions for each occupational group. Both the length of service and the cost of leaving were significant variables in all the logit equations. RAM III was used to forecast continuation rates for a version of the retirement system proposed by the Secretary of Defense (SECDEF).

Conclusions

1. The dynamic programming model appears to explain much of the occupational groups' retention behavior experienced in FY76 and FY77 under the current retirement system. Because of the large data requirements for such models, much organization and processing are required. Both the output from the dynamic programming model (the costs of leaving) and the LOS should be considered as possible predictor variables of retention rates for each group.

2. While previous models were designed to forecast Total Navy cost and behavior implications under alternative retirement systems, the model described in this report should be used to evaluate alternative economic incentives at any point in service in terms of resulting continuance behavior for the Navy's occupational communities.

3. Based on preliminary analyses of the SECDEF proposal, substantial differences in occupational retention are forecast relative to the current system. Particularly noticeable also are the various degrees of impact the retirement plan has on the 15 groups. This suggests that special attention be given to certain groups under proposed retirement systems.

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INTRODUCTION

Problem

An examination of alternative retirement systems is of particular importance due to retirement costs, which, in recent years, have increased more rapidly than defense manpower costs. A problem associated with alternative retirement systems, aside from their cost, is the behavioral implications for the Navy as a whole as well as occupational groups within the Navy. While an analysis of the Navy's total enlisted force may show some of the effects of alternative retirement systems, more detailed analyses of the various occupational communities may reveal severe personnel shortages. Prior to the imposition of any new retirement system, the Navy must be alerted to possible personnel deficiencies in its occupational communities.

Some factors to be considered in providing these types of analyses include (1) the economic incentives of a retirement policy, (2) promotional probabilities, (3) involuntary separation probabilities, and (4) civilian earnings opportunities. Any methodology designed to address the problem of retirement policy evaluation must also pay particular attention to the underlying assumptions.

Background

Increased interest in the military retirement system by Congress, military organizations, and the general public have led to recent efforts in the area of retirement modelling and analysis. A dynamic programming model for determining the value of remaining in the military as opposed to leaving or retiring was developed by Gotz of the RAND Corporation (Gotz & McCall, 1979). Several retirement models for enlisted personnel have sprung from Gotz's work, including those developed by the Center for Naval Analyses (Warner, in press); the Congressional Budget Office; the Personnel Analysis Division of HQ, USAF; and NAVPERSRANDCEN (Chipman & Mumm, 1978).[1] While these models provide forecasts for one or more services as a whole, no attempt has previously been made to explore the effects of alternative systems on occupational subgroups of enlisted personnel.

Objective and Scope

The objective of this report is to specify in detail the approach taken to forecast continuation behavior for 15 Navy enlisted occupational groups under alternative retirements systems. In addition, some illustrative results involving the SECDEF proposed system are provided. The methodology incorporates the Gotz dynamic programming model (described in Chipman, Silverman, & Willis, 1978). The report considers the data processing required for the Gotz model, a description and analysis of results from the Gotz model as applied to the 15 groups of enlisted ratings, the relationships between the output from the Gotz model and the voluntary retention rates of the occupational groups, and a summary of the retention and LOS continuation rate forecasting models.

Succeeding sections of the report offer some illustrative forecasts of an alternative retirement system using the model. The forecasts contained herein are clearly a result of the assumptions underlying the development of the Gotz model and its requisite data. Other assumptions and/or methods of data organization will naturally lead to different conclusions. The results described in this report are intended to indicate the capability for analyzing a variety of retirement plans as to both cost and force behavior. They are not intended as policy recommendations.

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[1]For a detailed comparison of these models, see Chipman, 1979.

APPROACH

Identification of 15 Occupational Groups

The Navy's 100 or so enlisted occupational specialties or ratings were divided into the following 15 occupational groups, each consisting of similar skills and similar retention behavior.

1. Ship Operations
2. Marine Engineering
3. Ship Maintenance
4. Aviation Maintenance/Weapons
5. Aviation Ground Support
6. Aviation Operations/Control
7. Weapons Control
8. Ordnance Systems
9. Sensor Operations
10. Construction
11. Health Care
12. Administration
13. Logistics
14. Media
15. Communications and Intelligence

These occupational groups were established by examining rating descriptions, training requirements, and rating behavior. Ratings whose personnel in the top six pay grades were relatively homogeneous, in terms of mean length of service (LOS), were grouped together. Similarity of mean LOS between two ratings connotes roughly similar promotion opportunities and loss behavior for those ratings. A lower mean LOS, on the other hand, would indicate a higher loss rate and a faster advancement rate. In addition, the occupational groups have roughly similar pay grade distributions. For statistical purposes, each group is composed of more than one rating. Table 1, which provides results of a one-way analysis of variance (ANOVA) performed to determine if there was a statistically significant difference in the mean LOS (for top six pay grades) of the 15 occupational groups, indicates that the groups differ significantly in terms of promotion opportunities and loss behavior.

Table 1

ANOVA Summary--Mean LOS of Occupational Groups

Source of Variation	Sum of Squares	DF	Mean Squares	F	P
Total	75.2534	70			
Between Groups	46.3513	14	3.3108	6.4150	< .0001
Within Groups	28.9021	56	.5161		

Determination of Civilian Earnings Opportunities

Comparable civilian earnings by pay grade and LOS for each of the 15 groups are required by the Gotz model. Thus, the civilian earnings opportunities for the 15 enlisted rating groups were determined based on 1977 data from the Computer-assisted Manpower Analyses System (CAMAS) of the Navy Office of Civilian Personnel (SECNAV, 1977). These data consist of income information for over 493,000 individuals covering 183 various job categories. The task of matching or equating enlisted military occupations with their civilian equivalents is essentially a judgmental process. The "mapping" of military to civilian occupations is particularly important since it determines the economic alternatives for personnel in each occupational category and, therefore, the cost of leaving military service. For this reason, official documents from a variety of sources were used to establish "comparability": U.S. Defense Manpower Commission (1975), Office of the Assistant Secretary of Defense (M&RA) (1972), Office of the Assistant Secretary of the Navy (M&RA) (1977), Armed Forces Vocational Testing Group (1975), and Office of the Assistant Secretary of Defense (MRA&L) (1977). The matchups between the 15 occupational groups and the CAMAS job categories, made after careful examination of these sources, are provided in Appendix A.

Since Navy civilian personnel are not representative of the national labor market, the average high school graduate earnings, listed in Table 2, were used as a base for determining the occupational groups' civilian earnings. These figures, which are 1975 values inflated for use for FY77, were deflated by a factor of 7.1 percent for FY76. The final figures were derived by multiplying the base figures by a weight less than, equal to, or greater than 1. This weight, which represents the relative earnings capability of each occupational group, is composed of two numbers. The first is an average skill salary derived from the matchups of the CAMAS job categories with the occupational groups; and the second, the average salary for all Navy civilian personnel, or $15,859 in 1977 dollars. Because not all discharged enlisted personnel obtain jobs in their particular skill rating, it was assumed that the average skill salary and the overall average each represents 50 percent of the earnings capability. Thus, the weight, W_j, to be applied to the Table 2 figures for occupational group j is

$$W_j = \frac{(\text{Average skill salary})_j + \$15{,}859}{2 * \$15{,}859}$$

The average skill salaries and relative earnings weights for all occupational groups are listed in Table 3.

Table 2

Average Civilian Income by Age for High School Graduates
(1975 Data, 1977 Dollars)

Age	Income	Age	Income
20	8394	43	16594
21	9551	44	16832
22	10169	45	17071
23	10786	46	17308
24	11403	47	17547
25	12020	48	17513
26	12637	49	17478
27	13254	50	17443
28	13581	51	17408
29	13910	52	17374
30	14237	53	17153
31	14565	54	16933
32	14893	55	16711
33	15139	56	16491
34	15385	57	16270
35	15632	58	16286
36	15878	59	16304
37	16125	60	16321
38	16170	61	16339
39	16216	62	16356
40	16261	63	16356
41	16311	64	16356
42	16356	64	16356

Table 3

Average Skill Salaries and Relative Earnings Weights for 15 Occupational Groups

Group	Title	Average Skill Salary	Relative Earnings Weight
1	Ship Operations	$ 13,873	.9374
2	Marine Engineering	16,168	1.0098
3	Ship Maintenance	15,793	.9979
4	Aviation Maintenance/Weapons	16,283	1.0134
5	Aviation Ground Support	14,716	.9640
6	Aviation Operations/Control	15,472	.9878
7	Weapons Control	17,710	1.0584
8	Ordnance Systems	15,338	.9836
9	Sensor Operations	16,821	1.0303
10	Construction	16,015	1.0049
11	Health Care	13,232	.9172
12	Administration	13,006	.9101
13	Logistics	14,072	.9436
14	Media	16,629	1.0243
15	Communications & Intelligence	13,573	.9279

Determination of the Cost of Leaving

For each of the 15 occupational groups, the Gotz dynamic programming model was used to calculate the difference between the value of staying in the Navy and the value of leaving for civilian employment. This difference, which is referred to as the cost of leaving (COL), is a monetary value expressed in discounted dollars. It is calculated for each LOS and pay grade. The value of staying in the Navy or leaving is the expected discounted present value of total earnings from the individual's current age until death (established through the use of mortality tables). A positive COL indicates that an individual should choose to stay in the Navy; and a negative COL, that he should leave.

The Gotz model assumes that military personnel are (1) long-term maximizers, (2) risk-neutral, and (3) possess perfect information regarding military and civilian earnings and military promotion and separation probabilities. A risk-neutral individual is one who, when given a choice of lifetime earnings paths, will choose the one that maximizes income. It is not essential that the assumptions are precisely true for every individual in order for the model to predict behavior in a reasonably accurate manner. It is only necessary that, in the aggregate, the sum of all individuals behave as if the assumptions were true.

Data required for the dynamic programming model include military promotion and involuntary separation probabilities by pay grade and LOS, the retirement system parameters (including severance, retirement, and early withdrawal multipliers), and mean civilian income by age. Data for 2 years, FY76 and FY77, were collected to estimate the relationship between the COLs and voluntary retention rates.

For military pay purposes, Navy Regular Military Compensation (RMC)[2] tables for FY76 and FY77 and average Navy incentive pay were included. The method of determining civilian earnings was described in the previous section.

Logit Analyses

To forecast future retention behavior for the occupational groups, current voluntary retention behavior must be related to current incentives. These incentives are obtained by calculating the average COL over FY76 and FY77 for each of the 279 cells (9 x 31) under the current retirement system. The current voluntary retention rates were computed (see Appendix B, page B-2, for method of computation) and averaged over FY76 and FY77. To illustrate the type of data encountered in all occupational groups, a plot of voluntary retention rates versus the costs of leaving for Occupational Group 1 (Ship Operations) is given in Figure 1. The curvilinear relationship in these data is apparent, with retention rates increasing as the COL increases. Since length of service (LOS) is considered to be another predictor of behavior, a plot of voluntary retention rate versus LOS for Occupational Group 1 is given in Figure 2. As shown, there is a positive relationship between LOS and retention rates between LOS cells 1 and 19. After that point, however, the relationship is not clear.

The logit function

$$r = 1/(1 + e^{-b_o - b_1x_1 - b_2x_2 - b_3x_3}), \quad (1)$$

where

r = voluntary retention rate

x_1 = COL

x_2 = LOS

x_3 = interaction term COL*LOS

was chosen as the prediction model after also examining an exponential and parabolic model. Although there was little difference in the goodness of fit between the exponential and logit models, the latter was selected because of its ability to limit the retention rates to values between 0 and 1.

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[2]RMC includes basic pay, quarters, and subsistence allowances.

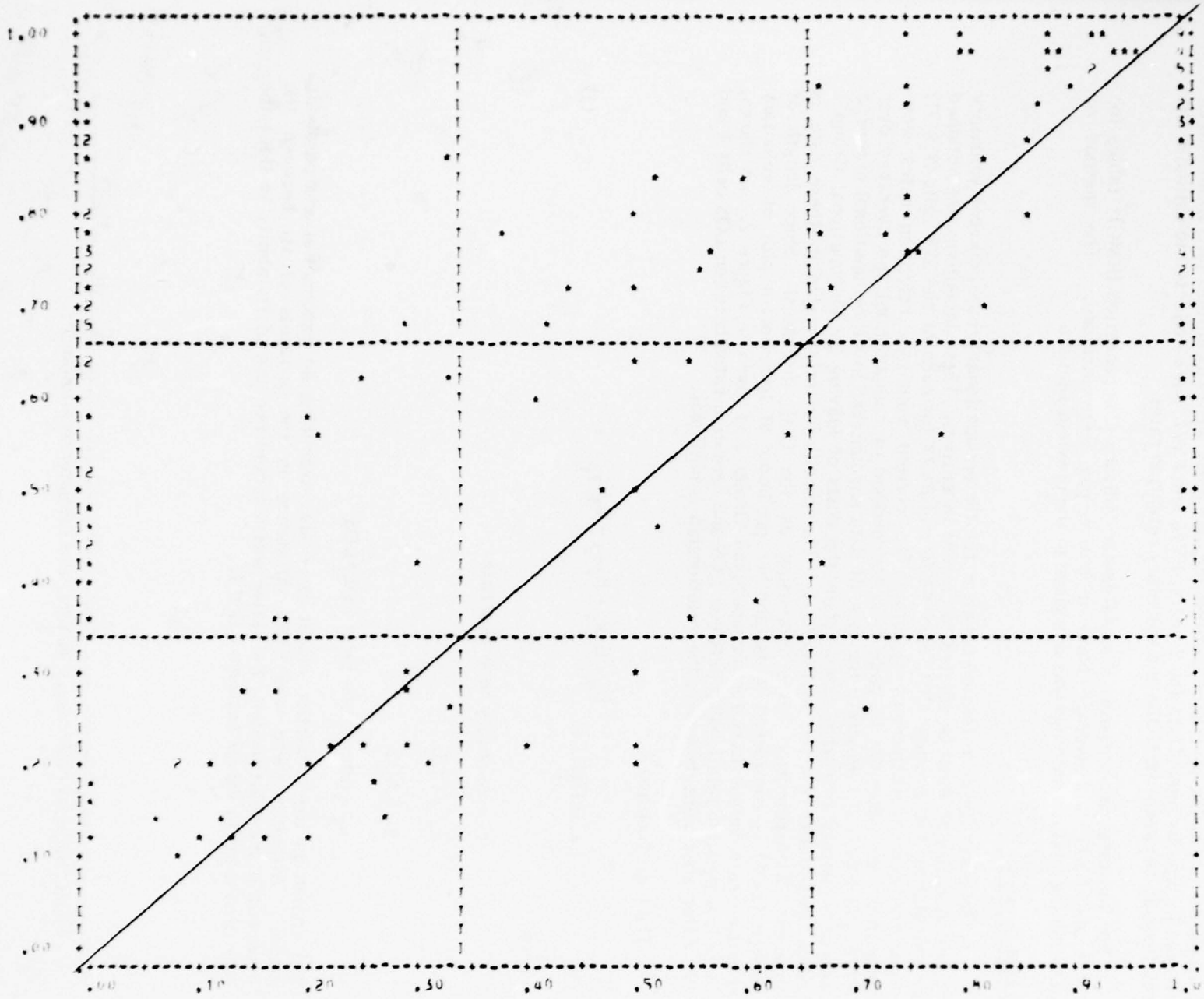

Figure 1. Scattergram of voluntary retention rates versus cost of leaving for Group 1.

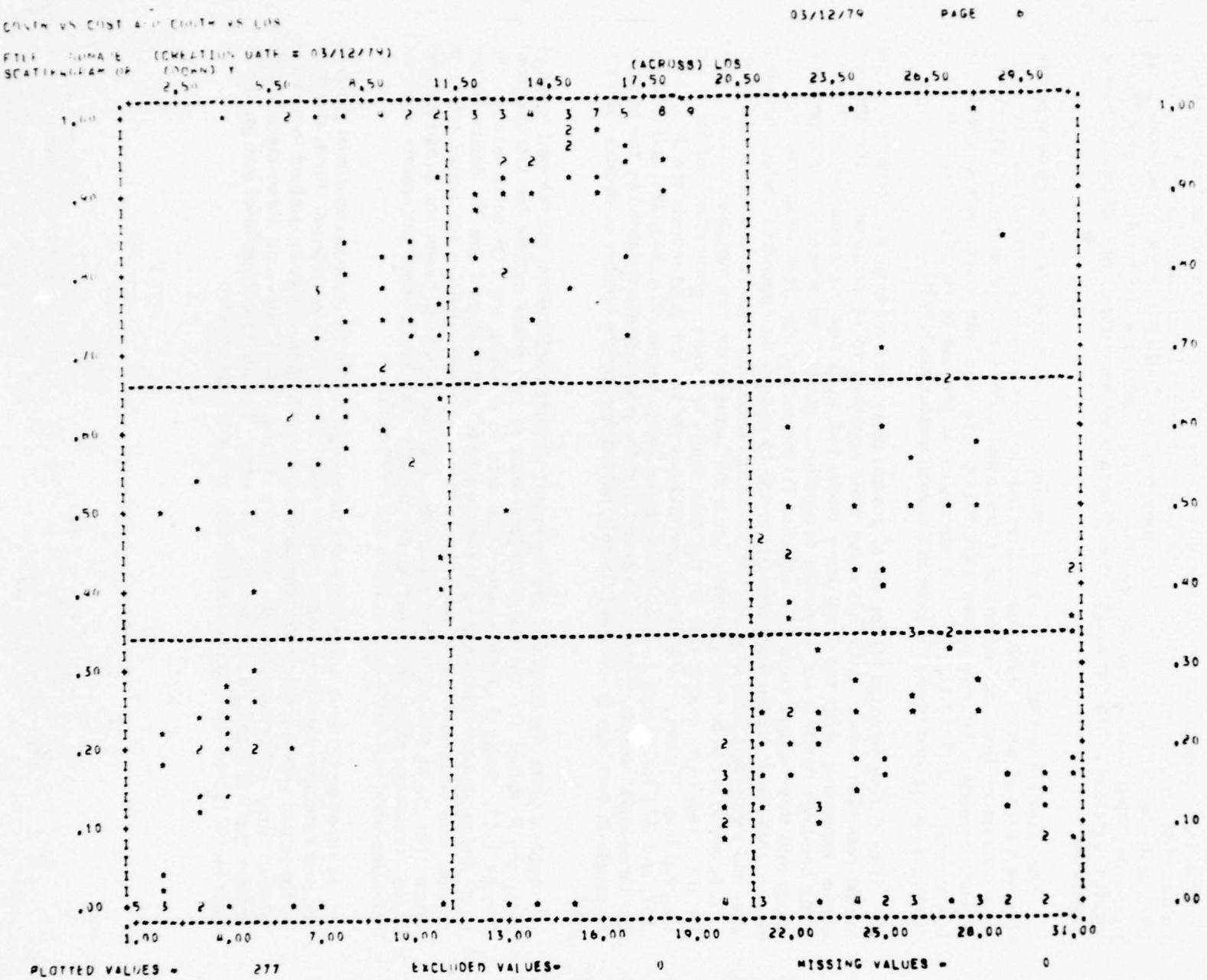

Figure 2. Scattergram of voluntary retention rates versus length of service for Group 1.

The LOS variable can be considered as a surrogate for economic and noneconomic factors that are not represented by the COL variable. The inclusion of an interaction term with the COL and LOS variables proved to be significant in the fitted models. It should be noted that all models presented in the report are the result of using least-squares regression, with the weight of each data point being the number of people making a decision.

The rationale is that the Navy enlisted force may be hypothesized as three separate "Navies," each of which views identical economic incentives in a different manner. The first consists of first- and second-term personnel (LOS 1 to approximately LOS 8); the second, careerists (approximately LOS 9-LOS 19); and the third, senior careerists (approximately LOS 20-LOS 31). A discussion of the use of the three separate logit functions (as opposed to one) is given in Chipman and Mumm (1978).

After fitting equation (1) for all 15 groups, plots were made of the predicted versus actual retention rates. Although these plots appeared to be reasonable, the authors' earlier experience with the Total Navy model indicated that a plausible alternative to using one-logit function for an entire occupational group is to divide each occupational group into three subgroups and fit equation (1) for each of the three subgroups. For this reason, three-logit models were also fit for the 15 groups. In Appendix C, which provides one- and three-logit plots of predicted and actual retention rates for Occupational Groups 1, 2, 6, and 9, it can be seen that the relationship between the two variables is more linear for the three-logit model; that is, the data points are more tightly clustered about the diagonal line. Further, the weighted correlations for the one-logit models are .873, .823, .857, and .671 for Groups 1, 2, 6, and 9 respectively, versus .951, .845, 884, and .897 for the three-logit models. It should be noted that the plots are not weighted by the number of people in each pay grade and LOS cell, but, rather, by the number of deciders in each cell.

Table 4 gives the constant, the dependent variable coefficients, the relevant range of LOS, and R values for the weighted-least-squares regression models for Occupational Groups 1-15. Several criteria were considered in choosing the LOS point between the first- and second-term personnel and the careerists (LOS Ranges 1 and 2). Basically, the division was made at the LOS point where there is a major jump in the actual retention rates; that is, at the point that maximizes the correlation between the predicted and actual retention rates, and that yields models that could most accurately forecast retention when validating against FY76 and FY77 data.

In choosing between a one-logit and three-logit model for each occupational group as the best retention rate forecasting method, two factors were considered. First, the plots of the actual versus predicted retention rates for both methods were examined for obvious biases. Most important, though, were the validations of one- and three-logit models against the FY76 and FY77 retention rate data. For all 15 occupational groups, the 3-logit model (Table 4) was judged better than the one-logit version.

Table 4

Logit Functions for 15 Occupational Groups

Group	Coefficient b_0 (Constant)	b_1	b_2	b_3	Relevant LOS Range	R[a]
Group 1	-2.564360	-.000218	.401697	.000037	1-7	
	2.724512	.000250	-.346840	-.000002	8-19	
	-4.741541	-.000090	.166220	.000009	20-31	
						.951
Group 2	1.407932	.001915	-.215946	-.000237	1-8	
	2.235585	.000340	-.241513	-.000010	9-19	
	-8.780247	-.000230	.332753	.000015	20-31	
						.845
Group 3	-.443495	.000774	-.207230	-.000184	1-5	
	.252160	.000238	.038679	-.000007	6-19	
	6.476881	.000346	.241214	-.000010	20-31	
						.901
Group 4	.208353	.001496	.064113	-.000175	1-8	
	1.712758	.000247	-.085765	-.000007	9-19	
	3.324280	.000234	.113202	-.000004	20-31	
						.943
Group 5	-2.251547	.000134	.358134	.000011	1-8	
	1.886126	.000517	-.160564	-.000018	9-19	
	-12.267740	-.000680	.534615	.000035	20-31	
						.878
Group 6	-1.829523	.000569	.291203	-.000064	1-8	
	-2.197841	.000356	.261669	-.000014	9-19	
	-10.515660	.000525	.946100	.000028	20-31	
						.884
Group 7	14.982100	.008434	-2.775376	-.001758	1-5	
	-3.105417	.000307	.327609	-.000014	6-19	
	-10.025090	-.000788	.389166	.000034	20-31	
						.925
Group 8	-1.285907	.000128	.190240	-.000005	1-8	
	1.114228	.000235	-.103959	-.000004	9-19	
	-6.161534	-.000225	.234258	.000012	20-31	
						.889
Group 9	5.812761	.004058	-1.135036	-0.000910	1-5	
	-3.927451	.000219	.470365	-.000011	6-19	
	-17.312320	-.001174	.759055	.000055	20-31	
						.844
Group 10	-1.403205	.001599	.300127	-.000163	1-8	
	1.493431	.000379	-.042278	-.000014	9-19	
	-5.600432	-.000019	.232538	.000004	20-31	
						.897
Group 11	-1.335780	.000820	.044531	-.000051	1-8	
	-1.953135	.000486	.072867	-.000019	9-19	
	-4.277782	.000150	.152594	-.000001	20-31	
						.926
Group 12	-2.085241	.000126	.245638	-.000003	1-8	
	-4.964065	.000394	.440606	-.000021	9-19	
	-5.568865	.000090	.205750	.000009	20-31	
						.943
Group 13	-1.178439	.000261	.135773	-.000071	1-5	
	-.037421	.000282	.118785	-.000011	6-19	
	-1.506834	.000228	.022661	-.000004	21-31	
						.970
Group 14	1.149248	.002266	-.342169	-.000352	1-5	
	-1.712392	.000337	.342355	-.000017	6-19	
	-6.359389	.000427	.289628	-.000007	20-31	
						.887
Group 15	-1.562721	.000724	.193092	-.000090	1-8	
	-4.726053	.000317	.418237	-.000014	9-19	
	-5.708702	.000363	.211712	-.000011	20-31	
						.922

[a]R represents the correlation between the forecasted and actual retention rates using all three models. For Occupational Group 13, the retention rate for LOS 20 is forecasted from the LOS 21-31 model.

RESULTS

This section will cover several topics. First, the continuation rate forecasting models and their validation under the current system will be briefly discussed. Then, the models will be used to forecast the continuation rates under both the current system and a version of the retirement system proposed by the Secretary of Defense (SECDEF). Finally, the forecasted continuation rates for several occupational groups under the SECDEF system will be compared.

LOS Continuation Rates

The procedure discussed by Chipman and Mumm (1978) was employed to calculate continuation rates for each occupational group. Initially, voluntary retention rates by LOS are determined by taking a weighted average of the rates across the pay grades. This procedure and the method of obtaining the weights are discussed in Appendix B, page B-2. The forecasted continuation rate for each LOS cell is determined by calculating an average of the voluntary retention rate for the deciders and the continuation rate for the nondeciders. A detailed discussion of the procedure followed in the calculation of the continuation rates is found in Appendix D.

Validation of RAM III

The interactive computer program known as Retirement Analysis Model III (RAM III) gives predictions of the voluntary retention rates and continuation rates by LOS for the occupational groups for nearly any type of retirement system. As was the case for RAM II, parameters describing the retirement system are input by means of prompts. All other data are built into the program. RAM III is currently operational on a UNIVAC 1110 in San Diego.

RAM III was validated under the current retirement system for each occupational group, using the average of FY76 and FY77 data. Sample validations are given in Appendix E, Table E-1, which lists the actual and predicted retention and continuation rates for Occupational Groups 1, 2, 6, and 9. The weighted mean absolute prediction errors for all groups are given in Table E-2. Discrepancies between actual and predicted retention rates in the lower LOS cells (1-3) may be attributed to the small number of individuals in these cells who are eligible to make a decision. For example, in LOS cell 1, the numbers in Groups 1, 2, 6, and 9 are only 10, 19, 1, and 2 respectively. Discrepancies exist in LOS cells 21-30 for the same reason. Examination of the signed discrepancies revealed that, in general, RAM III underpredicts for earlier LOS cells (1-8) and overpredicts for later LOS cells. This phenomenon is explained in a later section (see Elasticities, p. 15).

Prediction for Current and SECDEF Retirement Systems

The forecasted continuation rates for several occupational groups will be compared under the current system and version of the SECDEF Retirement System. The parameters for these two systems for enlisted personnel are summarized in Table 5. Although there is a provision in the SECDEF proposal for a social security offset of retirement earnings, the exact parameters were unknown at the time this report was written. Hence, this provision was not included in the table.

Under the current retirement system, there are no provisions for severance benefits, trust funds, or social security offsets. Retirement pay is computed as .025 (years of completed service) (final annual base pay) for individuals completing at least 20 years of service (YOS). Benefits are received immediately upon retirement.

Table 5

Retirement System Parameters for Current and SECDEF Systems

Parameter	Current System	SECDEF System			
		Immediate Annuity	Old Age Pension		Severance Pay
			Early Withdrawal	Regular	
Eligibility Requirement	20 or more YOS	20 or more YOS	10 or more YOS	10 or more YOS	5-19 YOS
Age/YOS over which receive annuity or payment	Immediate upon retirement for life	Immediate upon retirement until age 60	After 10 YOS eligible for lump sum payment	Age 60 for life	Lump sum payment
			Members with 20 or more YOS allowed old age pension and early withdrawal (but with reduced immediate annuity).		
Multiplier/method used in computation of annuity or payment	YOS x .025 for 20-30 YOS	.375 + .025 (YOS-20) for 20-30 YOS	(10 + 2 x number of years served between 11 and 15 YOS) monthly base pay	2.0/year for YOS 1-5 + 2.25/year for YOS 6-10 + 2.75/ year for number of years served beyond 10	5% x YOS
				At age 65, old age pension reduced by amount of social security attributed to military pay	
Base pay used	Final base pay	High 2-year average	Current base pay	High 2-year average	Final Base Pay

The intentions of the SECDEF Retirement System are to increase retention during the middle years of service, to encourage longer service among those eligible for retirement, and to reduce the overall cost of the system. The SECDEF system differs from the current system in the following respects:

1. It allows for benefits after 10 years of service.

2. Its immediate annuity multipliers are less than those for the current system.

3. Its annuities are based on a high 2-year average base pay rather than the final base pay.

4. It provides severance benefits.

Under the SECDEF system, members are entitled to a 20-year immediate annuity. Further, upon completion of 10 years of service, they are also entitled to an old age pension that begins at age 60. An "early withdrawal" option allows members to withdraw immediately, in cash, deferred old age benefits instead of waiting until age 60. Under this option, members draw 1 month's base pay for each year of service for the first 10 years of service. For each year served between 11 and 15 YOS, a member is entitled to receive 2 month's base pay. An individual who takes an "early withdrawal" is not entitled to the old age pension unless he remains in the military for at least 20 years of service. Individuals who receive both the "early withdrawal" and old age pension will receive a reduced immediate annuity until the age of 60. Finally, an enlisted individual who is involuntarily separated with 5-19 YOS is entitled to a lump sum severance benefit of 5 percent per YOS of his final basic pay.

The continuation rates for the current and SECDEF retirement systems, plotted for Occupational Groups 1, 2, 6, and 9, are included in Appendix F. Overall, for each group, the difference between the current and SECDEF plot is small. Further, for each group, the plots over the lower LOS cells (during first enlistment) are nearly identical. As LOS increases through approximately LOS cell 10 or 11, however, the SECDEF continuation rates become greater than those for the current system. This is due to the potential "early withdrawal" cash payments that encourage members to remain in the service. After LOS cells 11 or 12 through 19 (20 for Sensor Operations), the continuation rate is higher for the current retirement systems. This appears reasonable since the annuity at 20 YOS is greater under the current system. Beyond LOS 20 (21 for Sensor Operations), the continuation rates are higher for SECDEF. This may be attributed to the fact that a member has more to gain by remaining in the military beyond LOS 20 under SECDEF. By staying in the service, he is increasing his multipliers for both his immediate annuity and old age pension.

For comparison purposes, Appendix F also contains a plot of the continuation rates for Occupational Groups 1, 2, and 6 under the SECDEF system. Over LOS cells 6-8, members of Group 2 have the lowest continuation rate. A possible explanation is that the individuals in Group 2 have skills that have both the greater earning power and are in the greatest demand in the civilian environment (see Table 3). Members of Group 2 may have reenlisted due to the much higher reenlistment bonuses offered to them than to members of Groups 1 and 6. The lower continuation rates for Group 2 over LOS 20-24 may also be attributed to greater opportunities for civilian employment.

Elasticities

It is also worthwhile to examine the elasticity of the retention rate with respect to the cost of leaving (COL) for several of the occupational groups. The elasticities of the

logit functions can be used to estimate the increase in monetary benefits required to increase retention rates.

It was shown in Chipman and Mumm (1978) that the elasticity of the retention rate with respect to COL for an equation of the form $r = 1/(1 + \exp(-\beta x))$ is given as

$$\frac{dr}{dx} \, r/_x = \beta(1 - r)x \tag{2}$$

where x = COL.

Table 6 gives the expression for the changes in retention rate given a change in COL for occupational groups 2, 4, 6, and 10. These expressions are developed using (2) and the logit models for the four groups given in Table 4. Since, for each group, the first term inside the parentheses involving LOS is positive (for the appropriate LOS values), a positive change in COL produces a positive change in retention rate. The current retention rate, r, and the LOS cell also directly affect the change in retention rate. The elasticities for some of the groups are not meaningful due to the variability of the data associated with the small number of individuals in the group.

Table 6

Changes in Retention Rates with Respect to Cost of Leaving
for Four Occupational Groups

Group	∇r	Relevant LOS
2	(.001915-.000237*LOS)(1-r)*r* ∇ COL	1-8
	(.000340-.000010*LOS)(1-r)*r* ∇ COL	9-19
	(-.000230+.000015*LOS)(1-r)*r* ∇ COL	20-31
4	(.001496-.000175*LOS)(1-r)*r* ∇ COL	1-8
	(.000247-.000007*LOS)(1-r)*r* ∇ COL	9-19
	(.000234-.000004*LOS)(1-r)*r* ∇ COL	20-31
6	(.000569-.000064*LOS)(1-r)*r* ∇ COL	1-8
	(.000356-.000014*LOS)(1-r)*r* ∇ COL	9-19
	(-.000525+.000028*LOS)(1-r)*r* ∇ COL	20-31
10	(.001599-.000163*LOS)(1-r)*r* ∇ COL	1-8
	(.000379-.000014*LOS)(1-r)*r* ∇ COL	9-19
	(-.000019+.000004*LOS)(1-r)*r* ∇ COL	20-31

Using the expressions in Table 6, Table 7 provides the changes in retention rates predicted from a 10 percent increase in military pay for the groups 2, 4, 6, and 10. A base retention rate is assumed constant for each group in each pay grade and YOS combination. For E-6 and above, the four groups behave quite similiarly, with reasonable implied pay elasticities. For an E-6 with 12 YOS, the forecasted retention rate increases to 1.0, although the change in retention, (∇r), is actually computed to be greater than .15. Of interest also is that the mean LOS of the top six pay grades is relatively high (indicating lower promotion probabilities) for Groups 6 and 10, low for Group 2, and about average for Group 4. This fact is evidenced by the predicted changes in retention rates for an E-4 with 4 YOS. Here, it is predicted that Groups 6 and 10 will have much smaller increases

in their retention rate than Group 4, which, in turn, will have a smaller increase than Group 2. Thus, Table 7, for example, can be useful in determining the relative impact of bonus programs or alternative retirement systems on different occupational groups, although some of the actual increases in retention appear to be excessive.

Table 7

Change in Retention Rates Predicted from a Ten Percent Increase in Military Pay and Implied Pay Elasticities

Grade	YOS	Base Retention Rate (r)	Occupational Group	∇ COL	∇r	Pay Elasticity
E-4	4	.25	2	$4071	.74	29.60
			4	2982	.45	18.00
			6	5463	.32	12.80
			10	1251	.22	8.80
E-5	8	.56	2	8549	.04	0.71
			4	9168	.22	3.93
			6	8808	.12	2.14
			10	5900	.43	7.68
E-6	12	.85	2	9342	.26[a]	3.06
			4	9864	.20[a]	2.35
			6	9599	.23[a]	2.71
			10	9210	.25[a]	2.94
E-7	16	.93	2	9689	.11	1.18
			4	9731	.09	0.97
			6	9134	.08	0.86
			10	9408	.09	0.97
E-8	21	.56	2	5350	.11	1.96
			4	5367	.20	3.57
			6	5609	.09	1.61
			10	4668	.07	1.25

[a] ∇r would be limited to .15 with the elasticity being 1.76.

Because of the large increases in retention, some of the implied pay elasticities for the lower LOS cells are unreasonably high (e.g., greater than four). These abnormalities are due not only to the data but to the structure of the models themselves. As Gotz noted from his work, without a taste distribution variable in the forecasting model (to reflect the changing tastes for military life over time), the COL variable tends to pick up unwarranted credit for increasing retention rates as the COL increases.[3] The taste distribution, which requires longitudinal data to estimate, captures the fact that those with lesser tastes for military life leave earlier, hence increasing subsequent retention rates (even if there were no increase in the COL). Hence, any conclusions to be drawn from the lower LOS elasticities must consider this problem (see Chipman, (1979) for a more detailed discussion). Further efforts will concentrate on forecasting first- and second-term retention using such demographic variables as sex, race, education, mental category, etc.

The unwarranted credit attributed to the COL variable is also responsible for RAM III's general underprediction of early LOS retention rates and overprediction of later LOS retention rates. Here, the COL increases slowly in earlier LOS cells and very quickly in later LOS cells, while the mean of the taste distribution increases greatly in the earlier LOS cells and at a much slower rate in the later LOS cells. Even with the inclusion of a LOS variable as a surrogate for the taste distribution, which greatly helped cut down on the over- and underpredicting, the regression model still tends slightly to exhibit those tendencies.

The expressions in Table 6 may be used to estimate the additional monetary benefits required to bring the retention rates at each LOS to a desired level. Figures 3 and 4 illustrate the additional amount of money required to increase current retention rate by 10 percent for Occupational groups 2 and 4. For the LOS cells where the retention rate is high (over 9), the money required to raise the rate to 1.0 is plotted instead. These LOS cells and the amount the rates are increased is indicated on the figures. The results are similar to those found in the RAM II paper: Over LOS cells 9-19, there is a steady climb in bonus money for both groups (except for the Group 4 drop at LOS 19 because the retention rate was already at 1.0). Members who leave in these cells, especially nearer to cell 20, depart for nonmonetary reasons. Larger amounts of money are required to persuade them to stay. The sharp increase in bonus money required to raise the retention of Group 2 at LOS 8 is due to the appeal of the civilian job market. At LOS 8, these individuals are completing their initial period of reenlistment while possessing skills that are very marketable outside the military. Less bonus money is required to increase the retention of the Group 4 individuals at LOS 8.

[3]Personal communication between Dr. Gotz and the authors.

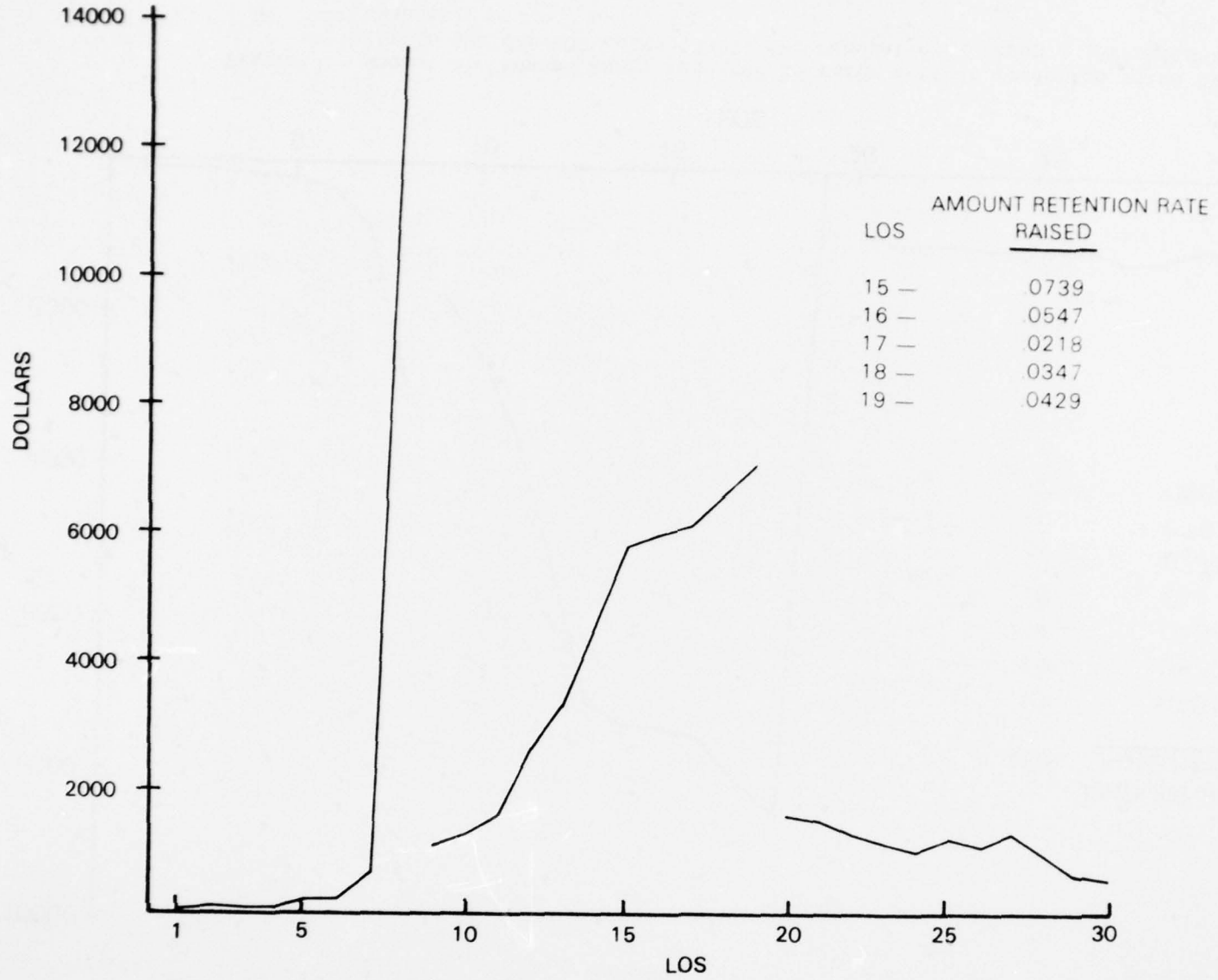

Figure 3. Amount of "bonus" money required to raise current retention rates by 10% (or to 1.0 for LOS cells 15-19) for Occupational Group 2 (Marine Engineering).

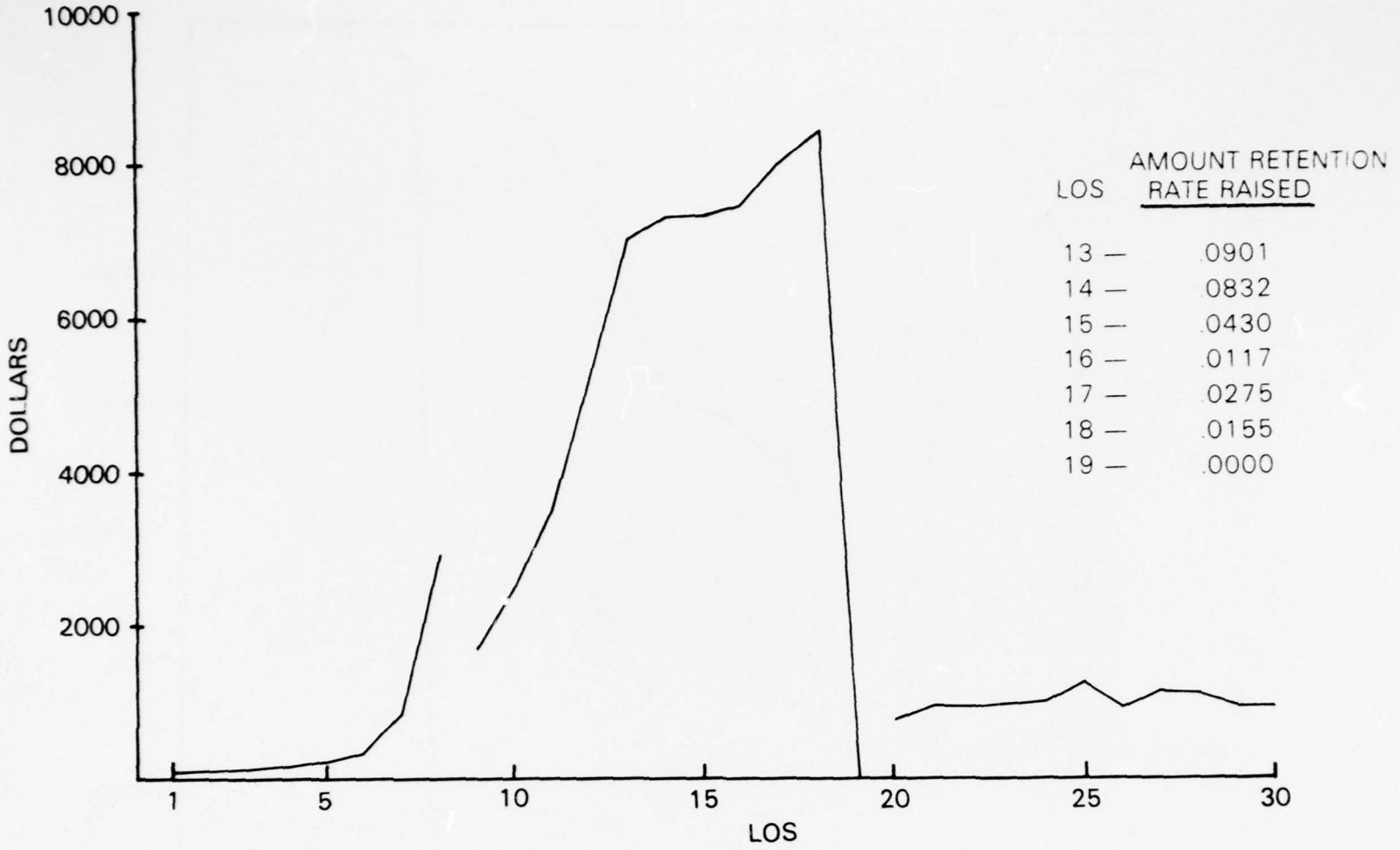

Figure 4. Amount of "bonus" money required to raise current retention rates by 10% (or to 1.0 for LOS cells 13-19) for Occupational Group 4 (Aviation Maintenance/ Weapons).

DISCUSSION AND CONCLUSIONS

Given a set of assumptions regarding the Navy enlisted personnel force structure and its occupational communities, it is possible to analyze the effects of alternative retirement policies on those communities. Once explicit, these assumptions, combined with the dynamic programming approach of modelling the enlisted retention decision, become the basis for those techniques embraced in the model called RAM III. For each of 15 occupational groups, the model predicts retention and continuation rates for LOS cells 1-30 based on a set of three logit functions. Since RAM III is a highly flexible, interactive model, the effects of many alternative retirement systems on any number of occupational groups can be analyzed in a short period of time.

Although Table E-2 indicates relatively acceptable errors in forecasting current retention and continuation rates, RAM III is probably more useful in other ways than in predicting force behavior under alternative systems. For instance, when analyzing a single occupational group, RAM III can provide estimates of the degree of change in retention rates for two or more retirement systems. Further, when analyzing a single retirement system, RAM III can provide predictions concerning which of two or more occupational groups would be "hardest hit" by that system. It should be recognized that changes in personnel policy (e.g., controlling lateral movements between ratings, establishing rating-specific bonus programs) may result in actual retention or continuation rates which differ considerably from the forecast.

The following conclusions are based on the findings and results described in this report:

1. The Navy enlisted force can be classified into 15 fairly homogeneous occupational groups based on rating skills, mean LOS of the top six pay grades, and pay grade distributions. Categorizing the enlisted force in such a manner allows comparative analyses of alternative retirement systems to be performed for the various occupational communities of the Navy, including high skill (critical) ratings.

2. The dynamic programming model appears to explain much of the 15 occupational groups' retention behavior experienced in FY76 and FY77 under the current retirement system. As a result of the statistical relationships, it is fair to conclude that a model can be developed that will forecast retention rates for the groups under a variety of alternative retirement systems. The data requirements for such a model are very large and require much organization and processing. Both the output from the dynamic programming model (the costs of leaving) and the LOS should be considered as possible predictor variables of retention rates for each occupational group.

3. While previous models were designed to cost alternative retirement systems or provide personnel force analyses at the Total Navy level, the model in this report can be used to evaluate alternative economic incentives at any point in service for any of 15 groups of skill ratings in terms of resulting continuance behavior.

4. Based on preliminary analyses of the current and proposed SECDEF retirement systems, differences in enlisted retention are forecast relative to the current system for each occupational group. Generally, increases in retention are forecast for LOS cells 4-10 and 20-30 while decreases are forecast for LOS cells 11-19. Since the latter segment of the force structure represents a critical cadre of experienced personnel, future retirement proposals should be evaluated very carefully in terms of their effect on force behavior. The model described in this report can provide the basis for such analyses.

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APPENDIX A

MATCH-UP BETWEEN ENLISTED OCCUPATIONAL GROUPS AND CAMAS JOB CATEGORIES

Table A-1

Match-up Between Enlisted Occupational Groups and CAMAS Job Categories

Enlisted Occupational Group	Title	Rating Abbreviation	Rating Title	Rating Number	CAMAS Job Categories	
1	Ship Operations	BM	Boatswains Mate	0100	Ship Operators	Technician NEC
		MA	Master at Arms	0150	Fixed Equip. Operators NEC	Riggers
		QM	Quartermaster	0200	Fixed Equip. Repairman NEC	Police & Detective
		SM	Signalman	0250		
		OS	Operations Specialist	0300		
2	Marine Engineering	MM	Machinists Mate	3700	Marine Machinist	Shipfitters
		EN	Engineman	3800	Marine Equip. Repairmen NEC	Electricians
		BT	Boilerman	4000	Electrical Line Workers	Power Plant & Elec.
		BR	Boilermaker	4020	Marine Carpenter	Motion Picture Craftsmen
		EM	Electricians Mate	4100	Telephone Installer and Repairmen	Power Plant Operators
		IC	Interior Communications Elec.	4200	Fixed Equip. Repairmen NEC	Automotive Mechanics
					Fixed Equip. Operators NEC	
3	Ship Maintenance	IM	Instrumentman	1100	Fabric & Leather Mechanics	Plastics Craftsmen
		OM	Opticalman	1200	Instrument Mech.-- General	Rubber Mechanics
		MR	Machinery Repairman	3900	Facilities Maint. Mechanic	Firemen
		HT	Hull Technician	4300	Instrument Mech. Electronic	Fixed Equipment Repairmen NEC
		PM	Patternmaker	4600	Boat Builder	Wood Craftsmen
		ML	Molder	4700	Marine Carpenter	Patternmakers
					Model Maker, Nonmetal	Shipwrights
					Marine Machinist	Shipfitters
					Marine Equipment Repairmen NEC	Model Makers, Metal
					Toolmakers	Machinists
					Machine Tool Operators NEC Welders	Molders
					Metal Processors NEC	Sheet Metal Mechanics
					Metal Fabricator	Pipefitters
					Pipe Coverer & Insulators	
					Pipefitting Craftsmen NEC	

Note. NEC = Not elsewhere covered.

Table A-1 (Continued)

Enlisted Occupational Group	Title	Rating Abbreviation	Rating Title	Rating Number	CAMAS Job Categories	
4	Aviation/Maintenance Weapons	AD	Aviation Machinists Mate	6200	Aircraft equip. Mechanics	Automotive Mechanics
		AT	Aviation Electronics Technician	6300	Fluid Systems Mechanics	Aircraft Overhaul Mech.
		AX	Aviation Antisub. Warfare Technician	6310	Electronics Mechanics	Electronics Mech. NEC
		AO	Aviation Ordnanceman	6500	Aircraft Inst. Mech. Elec.	Electronic Mech. Ordnance
		AE	Aviation Electricians Mate	6800	Ammunities & Explosives	Weapons Mech. & Repair
		AM	Aviation Structural Mech.	6900	Aircraft Instrument Mech.	Aircraft Electricians
		PR	Aircrew Survival Equipmentman	7000	Mechanic	Aircraft Electricians
		TD	Trademan	7200	Instrument Mech.-- General	Aircraft & Rocket Engine Mechanics
		AZ	Aviation Maintenance Administrationman	7400		
5	Aviation Ground Support	AB	Aviation Boatswains Mate	6700	Aircraft Equip. Mech.	Mobile Equip. Oper. NEC
		AS	Aviation Support Equip. Technician	7500	Aircraft Landing & Arresting Equip. Mech.	Mobile Equip. Repairmen NEC
6	Aviation Operations/ Control	AW	Aviation Antisub. Warfare Operator	6400	Air Traffic Control	
		AC	Air Controlman	6600	Fixed Equip. Operators NEC	
		AG	Aerographers Mate	7100	Physical Science Tech.	
7	Weapons Control	FT	Fire Control Tech.	0800	Electronics Tech.	Fire Control Mech.
		MT	Missile Technician	0810	Aircraft & Rocket Engine Mechanic	Electronics Mech. NEC
		ET	Electronics Technician	1000		Electronics Mechanic
		DS	Data Systems Technician	1010	Aircraft Inst. Mech. Elec.	
		AQ	Aviation Fire Control Technician	6520	Instrument Mech. Electronics	
8	Ordnance Systems	TM	Torpedomans Mate	0500	Ammunition & Explosives Mechanic	Weapons Mech. & Repair
		GM	Gunners Mate	0600		
		MN	Mineman	0900	Electronic Mech. Ordnance	

Note. NEC - Not elsewhere covered.

Table A-1 (Continued)

Enlisted Occupational Group	Title	Rating Abbreviation	Rating Title	Rating Number	CAMAS Job Categories	
9	Sensor Operations	EW	Electronics Warfare Technician	0350	Electronics Mechanic Electronics Technicians	Electronics Mech. NEC Fixed Equip. Operators NEC
		STG	Sonar Technician (Surface)	0401	Computer Tech. & Operators	
		STS	Sonar Technician (Submarine)	0404		
		OT	Ocean Systems Technician	0450		
10	Construction	EA	Engineering Aid	5100	Engineering Draftsmen	Engineering Technicians
		CE	Construction Electrician	5300	Electricians	Electrical Line Workers
		EO	Equipment Operator	5410	Electricians NEC	Automotive Mechanics
		CM	Construction Mechanic	5500	Mobile Equip. Repairmen NEC	Painters
		BU	Builder	5600		Masons, Plasterers, Roofers
		SW	Steel Worker	5700	Telephone Installer & Repairmen	Millwrights
		UT	Utilitiesman	5800	Power Plant Operators	Mobile Equip. Oper. NEC
					Mobile Equip. Metal Mechanic	Plumbers
					Heavy Duty Equip. Oper.	Carpenters
					Facilities Maint. Mech.	
11	Health Care	HM	Hospital Corpsman	8000	Medical Technicians	
		DT	Dental Technician	8300	Dental Technicians	
12	Administration	NC	Navy Counsellor	1400	Office Machine Operators	Mail & Messengers
		YN	Yeoman	1700	Legal Relations Workers	Clerical NEC
		LN	Legalman	1750	Management Tech. NEC	Computer Tech. & Oper.
		PN	Personnelman	1800	Travel Clerks	Computer Specialists
		DP	Data Processing Tech.	1900	Personnel Management	
		PC	Postal Clerk	2700		
13	Logistics	SK	Storekeeper	2000	Accounting Clerks	Payroll Clerks
		DK	Disbursing Clerk	2100	Shipping Clerks	Supply Clerks
		MS	Mess Management Specialist	2200	Logistics Clerks NEC	Launderers & Dry Cleaners
		SH	Ships Serviceman	2490	Food Service Workers	Ward Attendants
		AK	Aviation Storekeeper	7300	Supply Management Logistics Management	Transportation Management

Note. NEC = Not elsewhere covered.

Table A-1 (Continued)

Enlisted Occupational Group	Title	Rating Abbreviation	Rating Title	Rating Number	CAMAS Job Categories	
14	Media	JO	Journalist	2600	Illustrator	Information Workers NEC
		LI	Lithographer	3100	Photographer	*Printing* Craftsmen
		DM	Illustrator Draftsman	3200	Visual Information	Technical Writer
		MU	Musician	3300	Information Specialists NEC	
		PH	Photographers Mate	7600		
15	Communications Intelligence	RM	Radioman	1500	Communications Specialists	Communication Equip. Oper. Technicians NEC
		CTT	Communications Tech. (Technical)	1611	Electronics Technicians	
		CTA	Communications Tech. (Administration)	1622	Computer Tech. & Oper.	Clerical NEC
		CTM	Communications Technician (Maintenance)	1633	Intelligence Specialists	*Fixed Equip.* Oper. NEC
		CTO	Communications Technician (Communications)	1644		
		CTR	Communications Technician (Collective)	1655		
		CTI	Communications Technician (Interpretor)	1666		
		IS	Intelligence Specialist	2300		

Note. NEC = Not elsewhere covered.

APPENDIX B

DEVELOPMENT OF DATA REQUIREMENTS

DEVELOPMENT OF DATA REQUIREMENTS

To satisfy the various data requirements for the dynamic programming model and the subsequent behavior forecasting models, Total Navy enlisted personnel movements for the 15 occupational groups for FY76 and FY77 were divided into several categories of changes (e.g., promotion, retirements, etc.). The data source was the Enlisted Personnel Planning Data Base (sometimes referred to as FAIM). The following variable identification numbers (VID) were used in defining the data:

Variable ID	Title
127	All Navy ineligibles
129	All Navy attrition
150	All Navy retirement
209	All Navy nonreenlistment
227	All Navy total eligible exp/sep--extended
410	All Navy continued service/broken service
433	USNR nonprior service
475	All Navy miscellaneous gains
500	All Navy total first enlistment
640	All Navy combined retention
817	All Navy promotions
830	All Navy demotions in
999	All Navy begin inventory

Each variable ID is the form of a pay grade by length of service (LOS) (9 x 31) data array in which the LOS is computed to the beginning of a fiscal year. That is, the pay grade/LOS cell for each variable is determined by the individual's pay grade/LOS cell at the beginning of the fiscal year. For example, for a person who is an E-3 in LOS cell 4 at the beginning of the fiscal year and is promoted to an E-4 during the fiscal year, a count will be registered in the E-3/LOS 4 cell of VID 817. Since all the VIDs are begin-year, a fair amount of consistency is obtained in the following data definitions. The indicated division is on a cell-by-cell basis. VID 999 is, of course, begin-year by definition.

1. The conditional probability of a promotion, given that one is not involuntarily separated, for a given pay grade/LOS cell is

$$\Pr(\text{Promotion} \mid \text{No involuntary separation}) = 817/(999 + 410 + 433 + 475 + 500 + 830 - 150 - 209 - 127 - 129).$$

In other words, it is the number of promotions divided by the net fiscal year's inventory less involuntary separations (127 + 129). Adding in the gains (410 + 433 + 475 + 500 + 830) and subtracting the losses (150 + 209) to the begin inventory 999 yields the net inventory for the fiscal year. That is, for each pay grade/LOS cell, the persons who were eligible for promotion (the denominator) includes those who were present at the beginning of the year plus any gains to that pay grade/LOS cell during the year less any losses from that pay grade/LOS cell during the cell. The probabilities are made conditional by subtracting the involuntary separations from the net inventory. This is a requirement of the Gotz dynamic programming model.

2. The probability of being involuntarily separated, for a given pay grade/LOS cell, is

$$\Pr(\text{Involuntary Separation}) = (127 + 129)/(999 + 410 + 433 + 475 + 500 + 830 - 150 - 209).$$

The rationale follows the same lines as for the promotion probabilities.

3. The voluntary retention rates, matched with the costs of leaving from the dynamic programming model to determine the appropriate logit functions, are defined as:

$$\text{Voluntary Retention Rate} = 640/(150 + 227)$$

Thus, the rates are the number of people who continue in service divided by the number of people eligible to make a decision to continue. Recall, though, that the actual rates for each year, with the corresponding cost of leaving, were used to determine the logit functions, not the average values.

4. The weights assigned to each pay grade to determine one voluntary retention rate for each LOS cell are computed as:

$$\text{Pay Grade Weights} = (227 + 150)_{ij}/(227 + 150)_{j} \qquad \begin{matrix} i = 1,\ldots,9 \text{ pay grades} \\ j = 1,\ldots,31 \text{ LOS cells} \end{matrix}$$

or the cell-by-cell number of deciders divided by the total number of deciders for each LOS cell (the marginal total summed over all pay grades). Obviously, the weights must add to 1 when summed over the 9 pay grades for each LOS cell.

5. The proportions of deciders, the number of people in each LOS cell who are eligible to make a decision to stay or leave, is a 1 x 31 vector and is calculated as:

$$\text{Proportion of Deciders} = (227 + 150)_{j}/999_{j} \qquad j = 1,\ldots,31 \text{ LOS cells.}$$

These numbers are used in combining the forecasted retention rates with the nondecider's continuation rates to give an overall LOS continuation rate.

APPENDIX C

PLOTS OF PREDICTED AND ACTUAL RETENTION RATES FOR GROUPS 1, 2, 6, AND 9: ONE- AND THREE-LOGIT MODELS

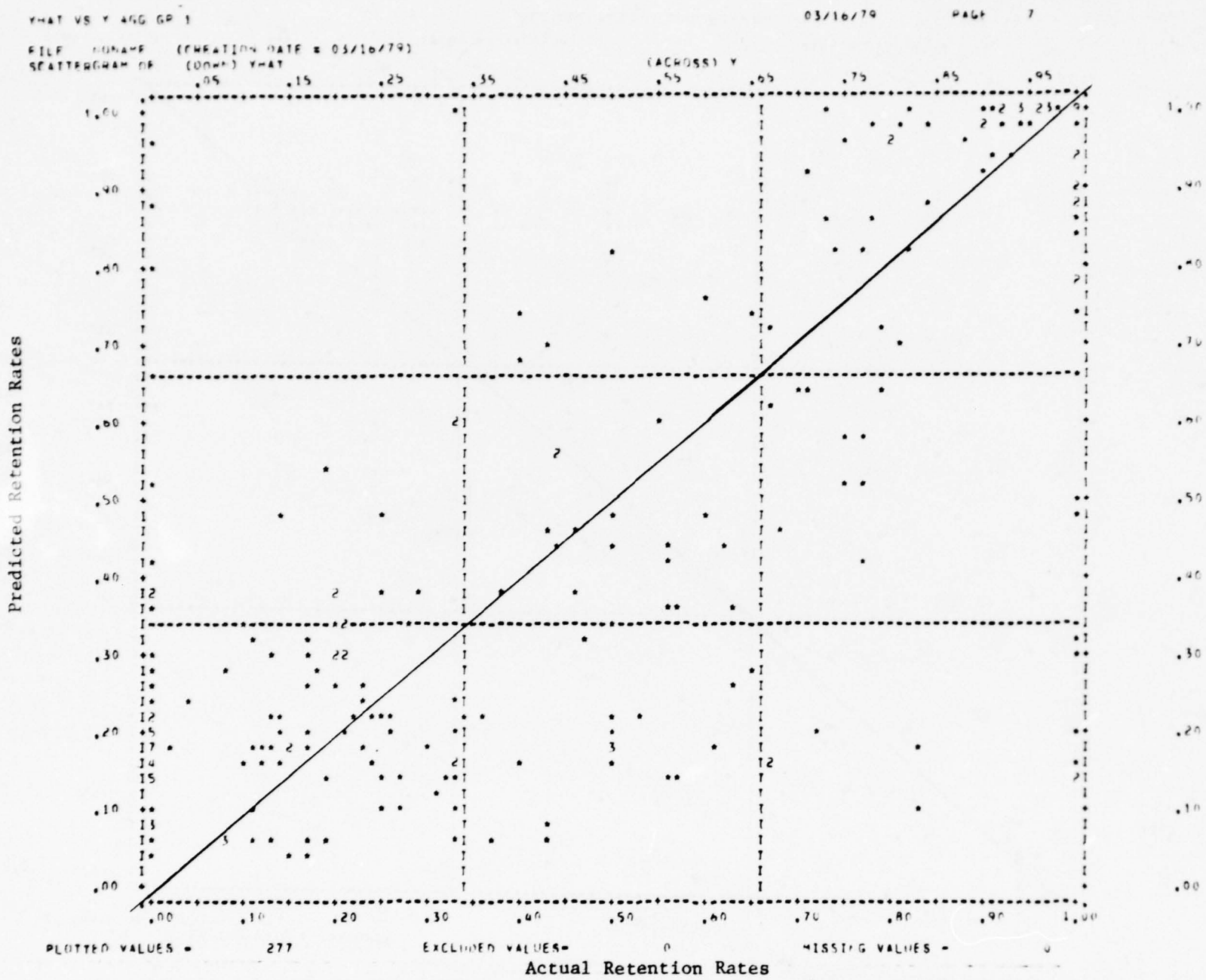


Figure C-1. Plots of predicted and actual retention rates for one logit model for Group 1.

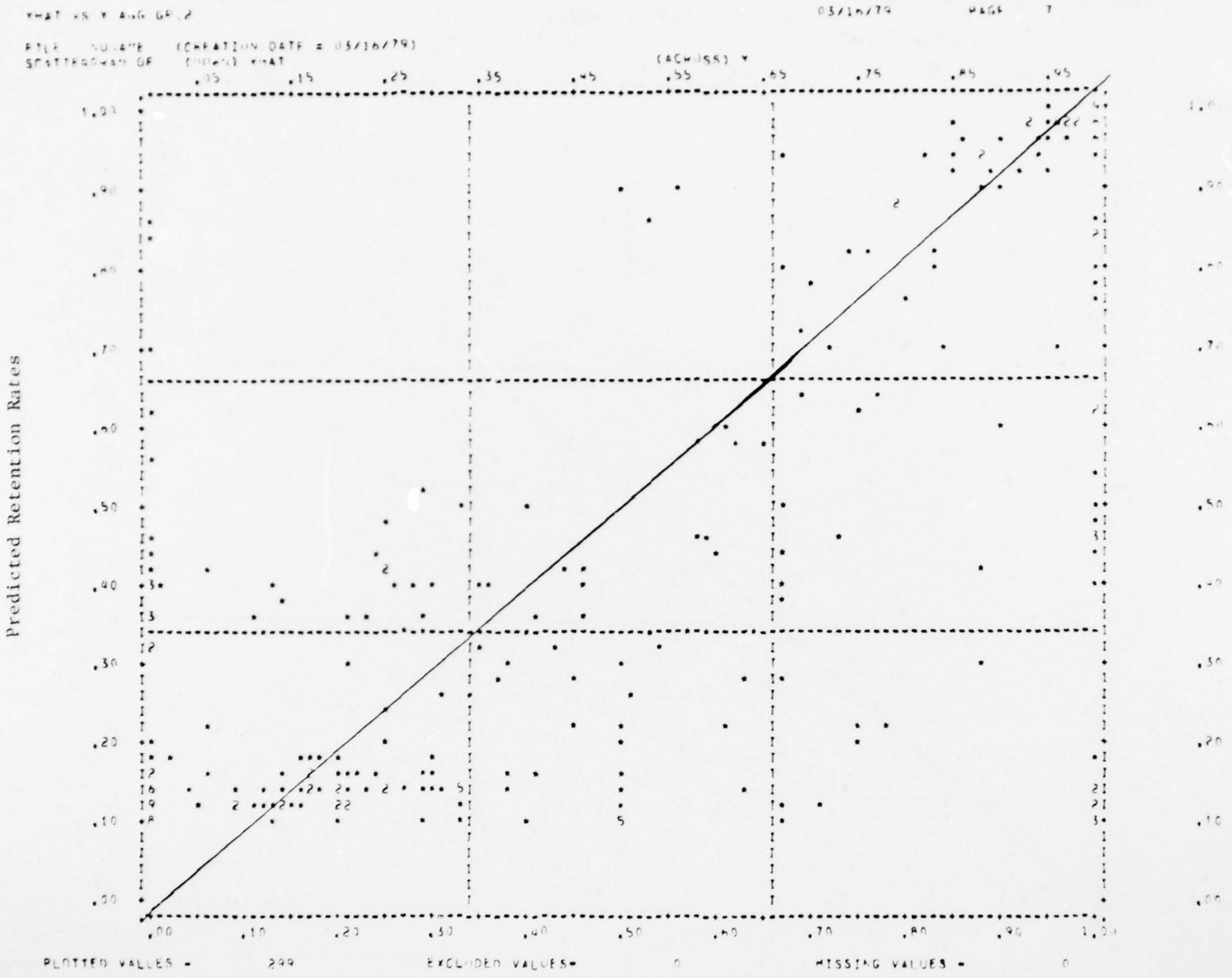


Figure C-2. Plots of predicted and actual retention rates for one logit model for Group 2.

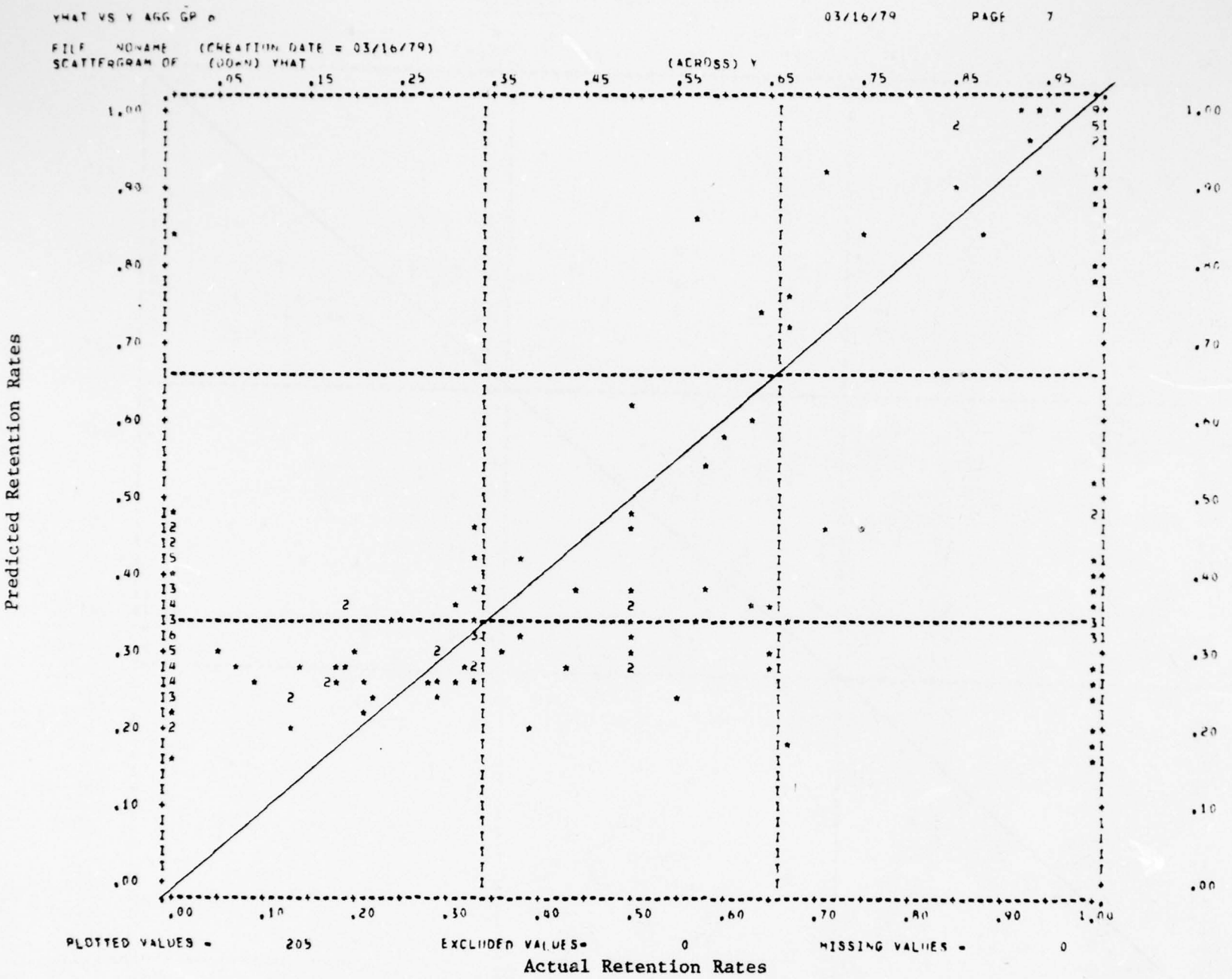


Figure C-3. Plots of predicted and actual retention rates for one logit model for Group 6.

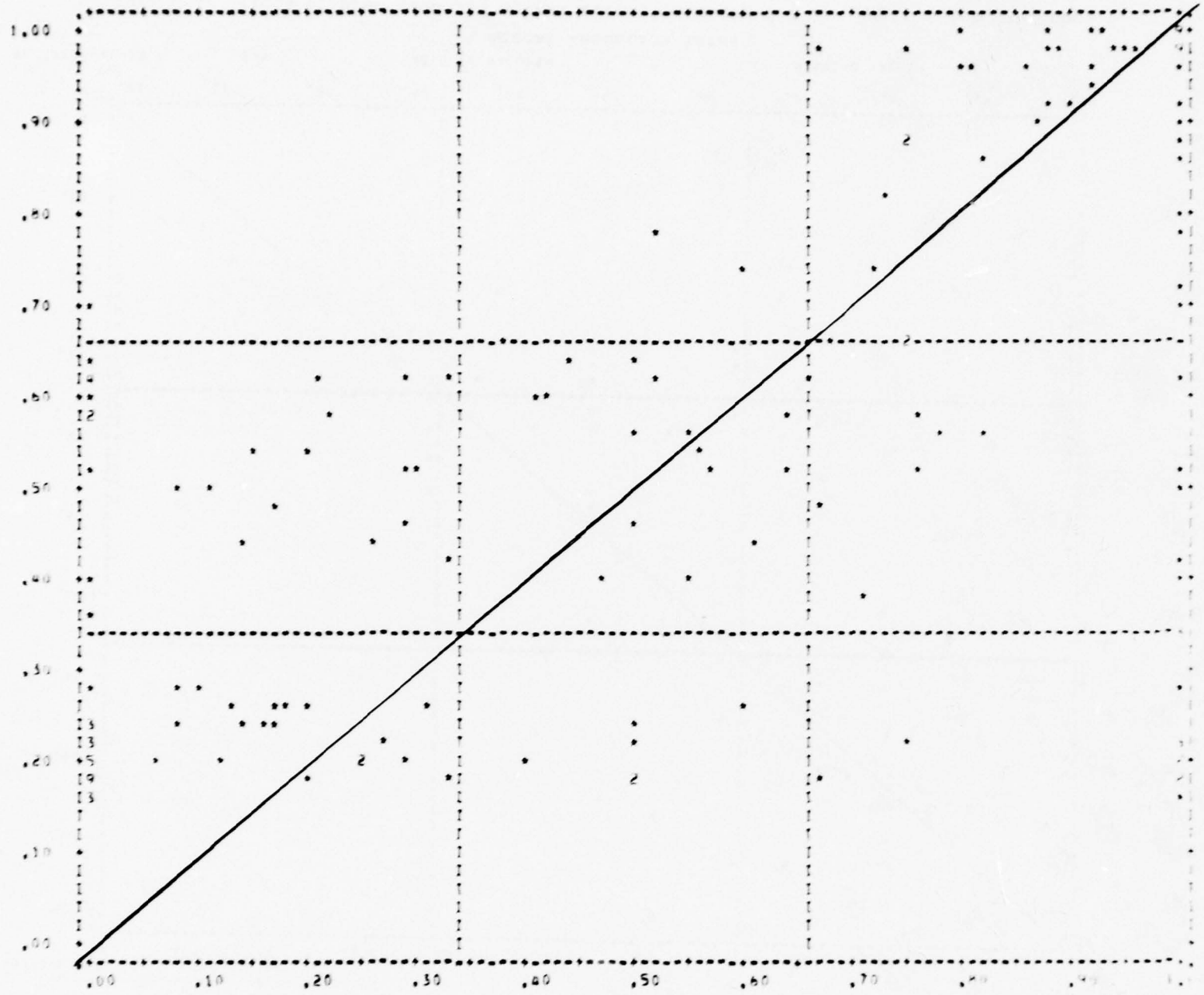
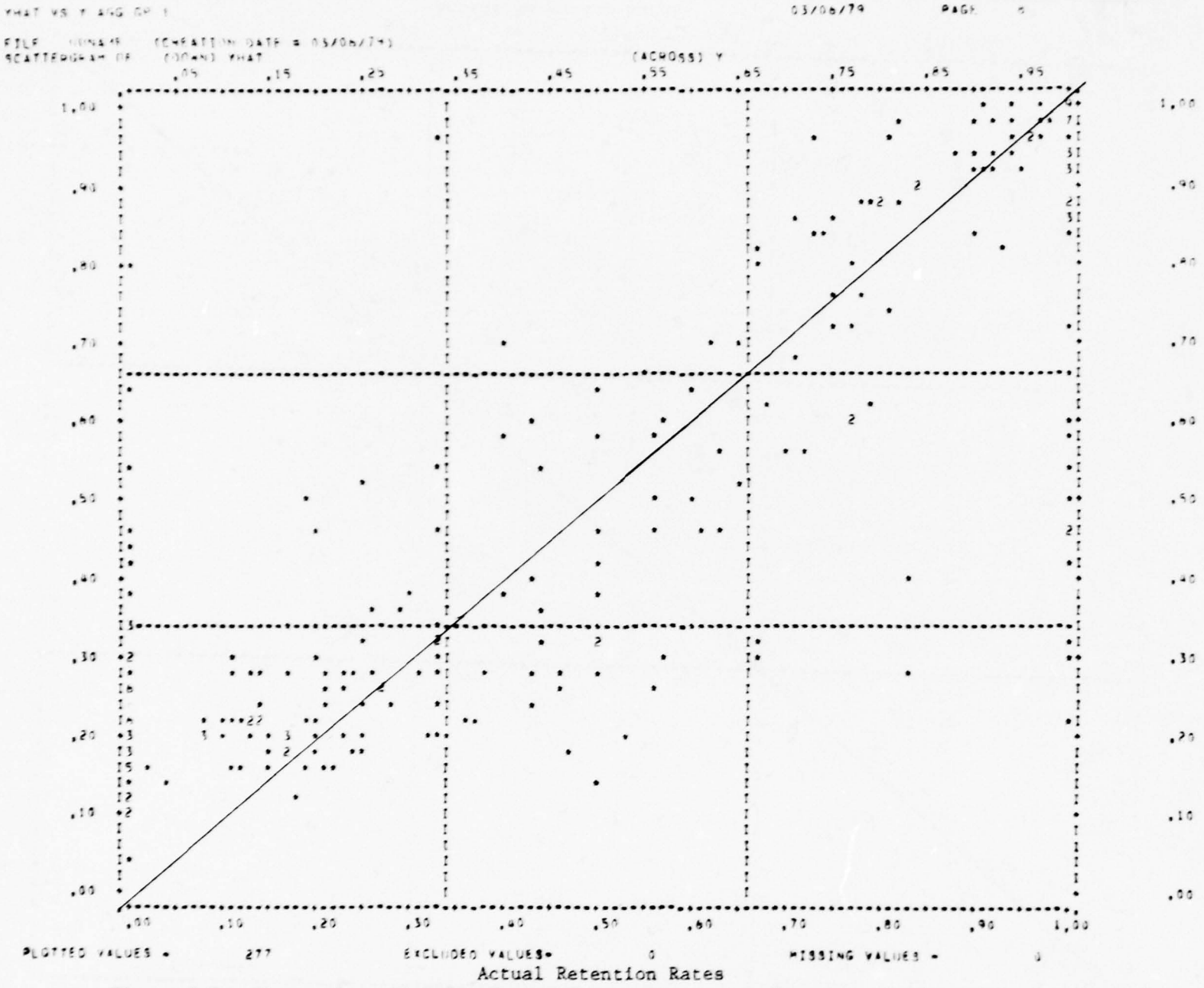


Figure C-4. Plots of predicted and actual retention rates for one logit model for Group 9.



Predicted Retention Rates

Actual Retention Rates

Figure C-5. Plots of predicted and actual retention rates for three logit models for Group 1.

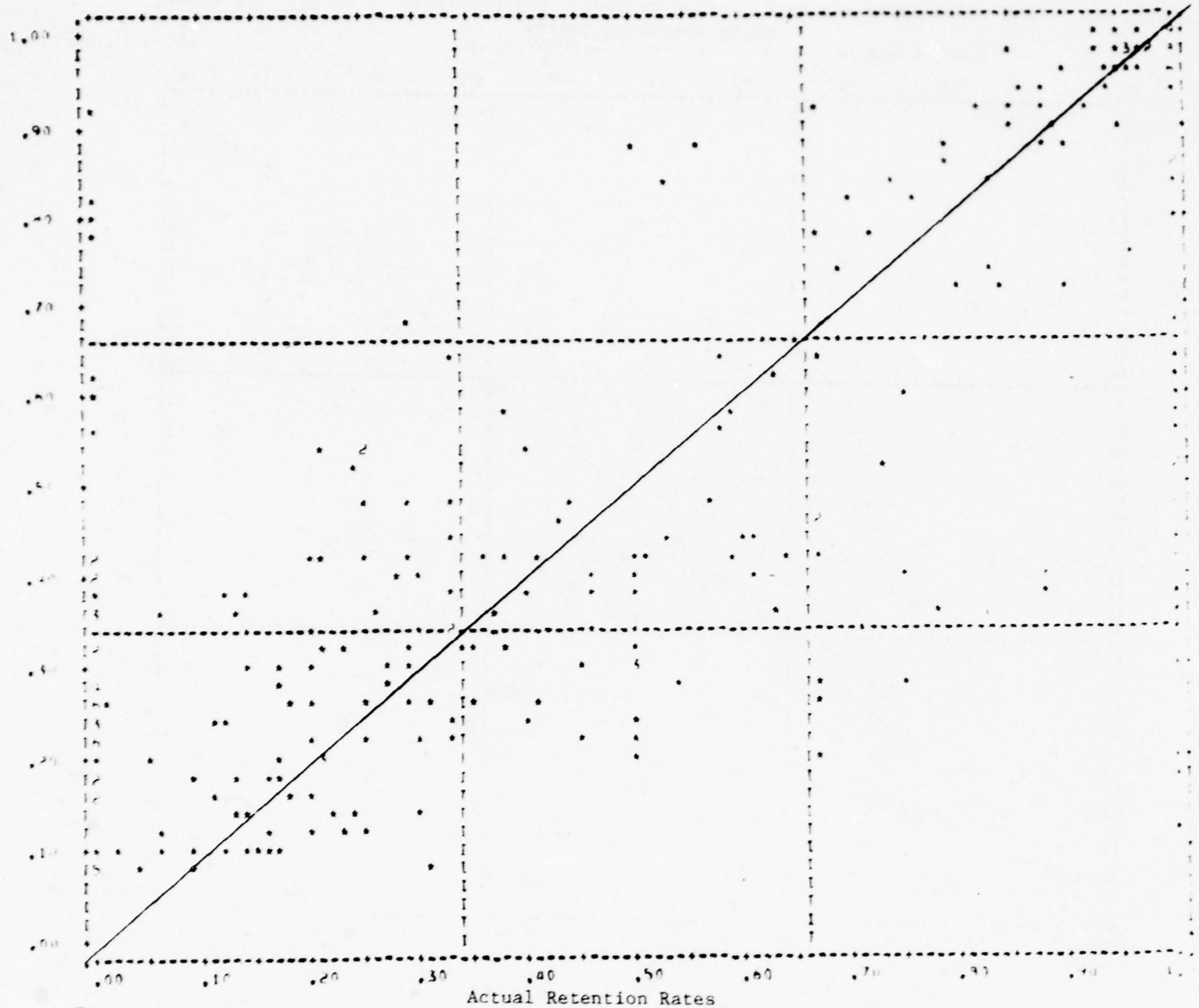


Figure C-6. Plots of predicted and actual retention rates for three logit models in Group 2.

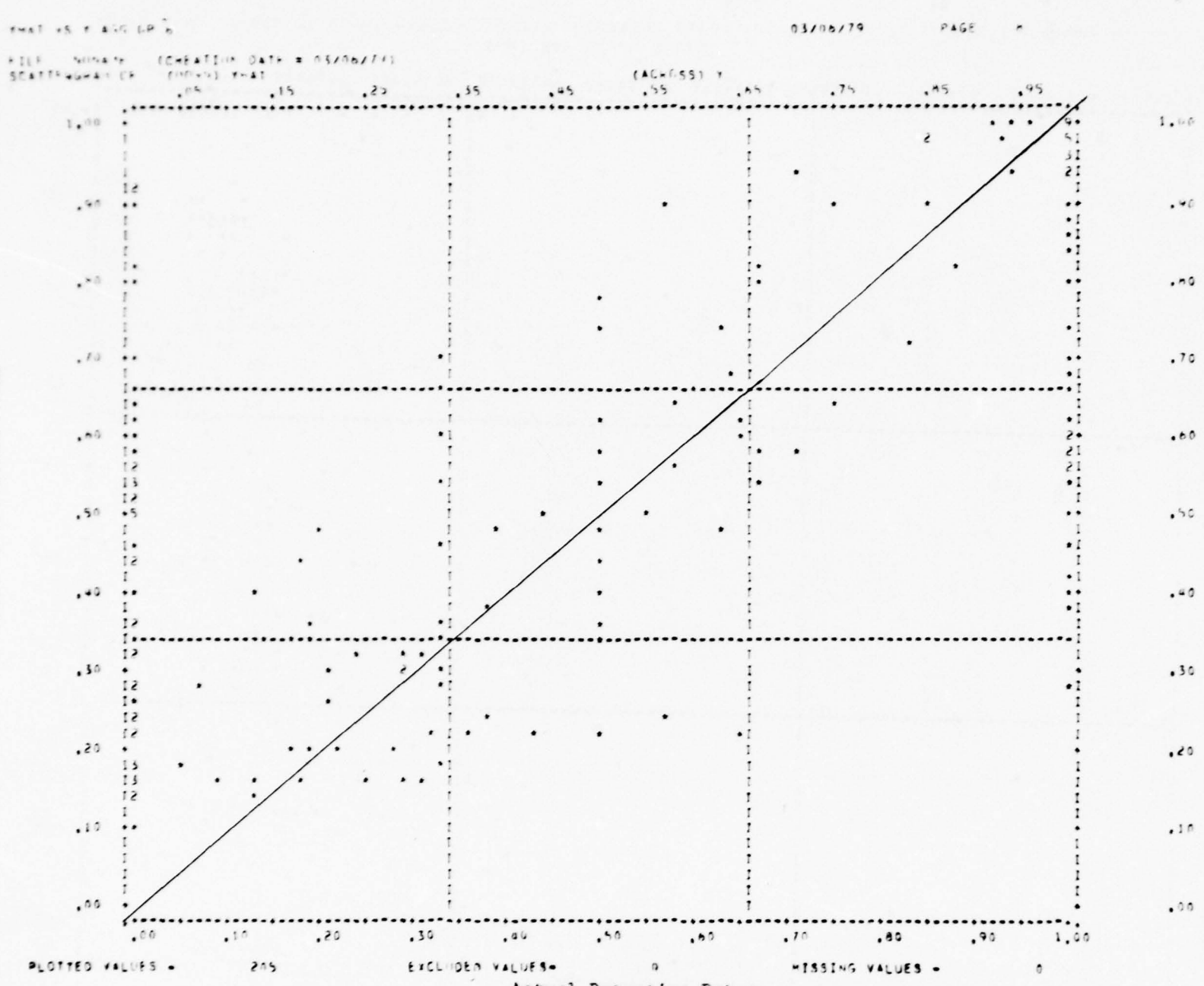


Figure C-7. Plots of predicted and actual retention rates for three logit models for Group 6.

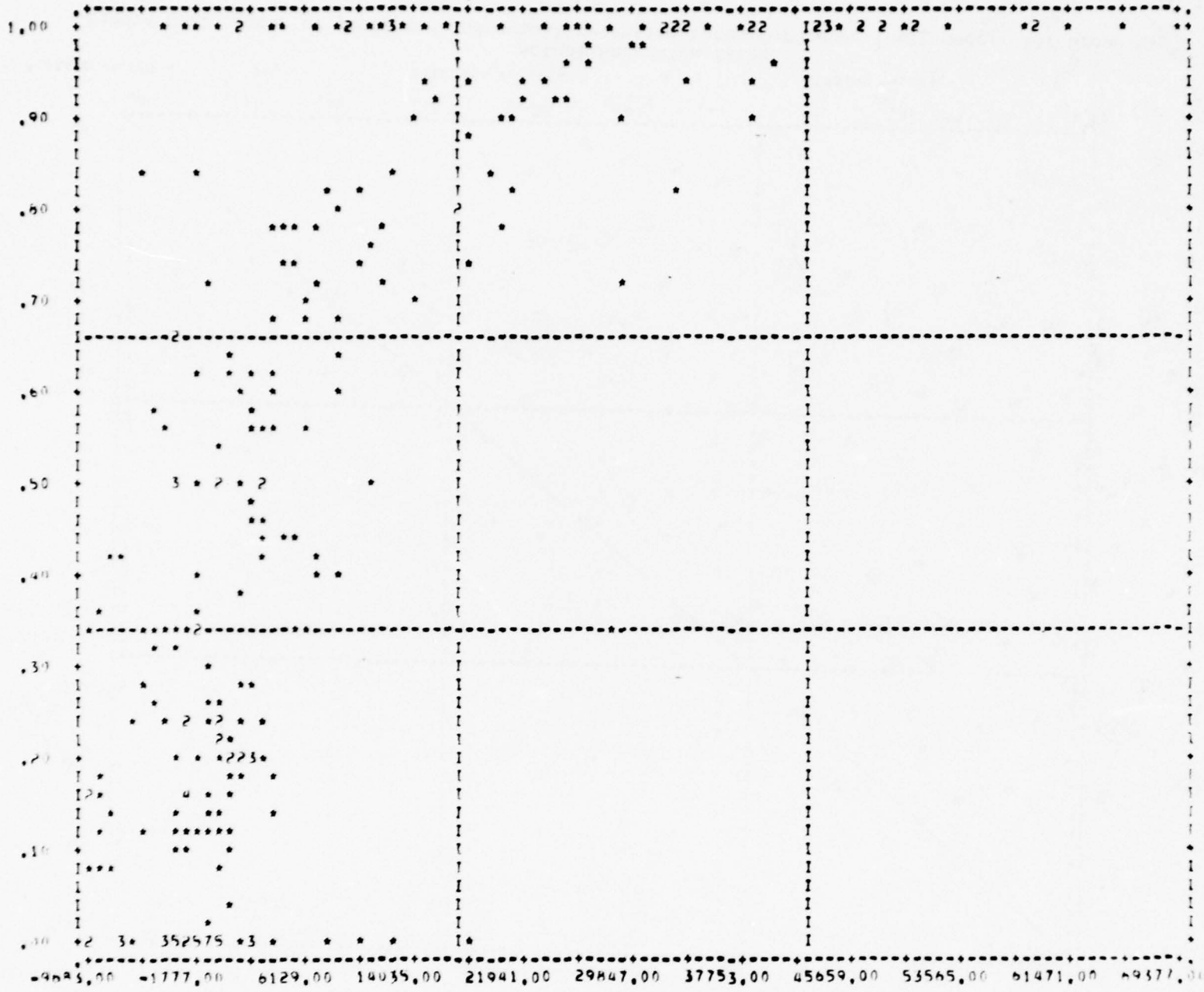


Figure C-8. Plots of predicted and actual retention rates for three logit models for Group 9.

APPENDIX D

PROCEDURE FOR CALCULATING LOS CONTINUATION RATES

PROCEDURE FOR CALCULATING LOS CONTINUATION RATES

The LOS continuation rates, which represent a combination of the voluntary retention rates for the deciders and the continuation rates for the nondeciders, must be determined after obtaining the forecasted voluntary retention rates from the logit functions. This procedure is accomplished in two steps requiring the use of two sets of data for each occupational group.

First, after all 279 (9 x 31) predictions are made, a combined retention rate for each LOS cell is computed by applying a set of pay grade weights to the nine predictions relevant to each LOS cell. The method involved in determining these rates is contained in Appendix B. The weights are based on the number of personnel by pay grade eligible to make a stay/leave decision.

Once the voluntary retention rates are known for each LOS cell, they must be combined with the continuation rates for those people not making a decision (e.g., the "nondeciders"). One set of data, then, is the proportion of deciders and nondeciders for each LOS cell. The method for determining them is detailed in Appendix B. The only other factors requiring definition are the continuation rates for the nondeciders. Due to such occurrences as death, desertion, and court martial, these rates should be less than 1.

They were derived from the following equation:

$$V_j * PV_j + IV_j * (1.-PV_j) = C_j \qquad \text{for } j=1,\ldots,31 \qquad (1)$$

where, for a given occupational group, V_j = voluntary retention rates for LOS cell j, PV_j = proportion of deciders, IV_j = continuation rate for nondeciders, and C_j = current LOS (PEBD) continuation rate. The IV_j's can easily be determined since all other variables are known. The V_j's, PV_j's, and C_j's in equation (1) were all derived from the average of FY76 and FY77 data.

Thus, in the continuation rate forecasting model, the V_j's are supplied by the logit functions, the PV_j's and IV_j's are known, and equation (1) is applied to yield predictions of the occupational group LOS continuation rates, the C_j's.

APPENDIX E

VALIDATION OF RAM III

Table E-1

Actual and Predicted Retention, Continuation Rates for Occupational Group 1 Under Current System

	Retention		Continuation	
LOS	Actual	Predicted	Actual	Predicted
		Occupational Group 1		
1	.0000	.1169	2.4022	2.4028
2	.1594	.1520	1.1203	1.1189
3	.2337	.2067	.9076	1.0921
4	.2413	.2764	.4924	.5168
5	.3137	.3636	.8714	.8871
6	.5671	.4630	1.2404	1.2269
7	.7135	.5852	1.1639	1.1443
8	.6660	.7068	.9548	.9689
9	.7373	.7519	1.0080	1.0110
10	.7739	.7976	.9032	.9094
11	.7674	.8177	1.0272	1.0350
12	.8515	.8718	.9543	.9580
13	.8616	.8093	1.0121	1.0206
14	.9191	.9368	.9400	.9434
15	.9529	.9606	.9339	.9354
16	.9681	.9779	1.0404	1.0417
17	.9226	.9886	.9832	.9916
18	.9796	.9939	.9955	.9967
19	1.0000	.9969	.7345	.9970
20	.1458	.1673	.6328	.6493
21	.2303	.1878	.6460	.6290
22	.3162	.2598	.7744	.7526
23	.1830	.2378	.6891	.7102
24	.2792	.3276	.6736	.6914
25	.3622	.5193	.9388	.9902
26	.3470	.2967	.7266	.7095
27	.3988	.2751	.8140	.7719
28	.3364	.2779	.7758	.7633
29	.2756	.2736	.9890	.9883
30	.1854	.2287	.5726	.5940

Table E-1 (Continued)

	Retention		Continuation	
LOS	Actual	Predicted	Actual	Predicted
	Occupational Group 2			
1	.1603	.4779	2.5816	2.5828
2	.5327	.4048	.9160	.9092
3	.3578	.3753	.8431	.8467
4	.3722	.3984	.5534	.5690
5	.4478	.3070	.8146	.7788
6	.2140	.3602	.8335	.8733
7	.4168	.3753	.9360	.9291
8	.6066	.4196	.8960	.8438
9	.6462	.6423	.9661	.9653
10	.6681	.7083	.8271	.8400
11	.7270	.7731	.9444	.9519
12	.8211	.8351	.9677	.9710
13	.8541	.8859	.9455	.9519
14	.8888	.9194	.9508	.9573
15	.9261	.9394	.9363	.9391
16	.9453	.9687	.9965	1.0007
17	.9782	.9799	.9528	.9533
18	.9653	.9874	.9606	.9624
19	.9571	.9894	.7021	.9619
20	.0872	.0934	.5576	.5630
21	.1792	.1201	.6048	.6219
22	.1934	.1910	.6643	.6650
23	.2062	.2007	.5931	.5904
24	.1865	.2845	.5932	.6383
25	.3958	.5561	.9386	.9948
26	.3875	.3005	.7376	.6992
27	.5417	.3092	.8837	.8246
28	.3889	.3551	.9069	.9012
29	.1889	.4134	.6472	.7226
30	.1785	.3304	.5782	.6704

Table E-1 (Continued)

	Retention		Continuation	
LOS	Actual	Predicted	Actual	Predicted
		Occupational Group 6		
1	.0000	.1131	4.7136	4.7152
2	.0297	.1715	.9385	.9463
3	.3483	.2190	.8589	.8429
4	.2680	.2956	.5186	.5355
5	.2765	.3240	.8387	.8534
6	.4750	.4262	.9656	.9606
7	.5619	.5367	1.0056	1.0030
8	.6570	.6369	.9761	.9718
9	.7127	.7159	.9409	.9414
10	.7494	.8599	.8948	.9314
11	.7944	.9169	.9487	.9682
12	.8571	.9604	1.9546	1.9715
13	.9194	.9793	.9451	.9575
14	.9653	.9898	1.0044	1.0073
15	1.0000	.9949	.8907	.8903
16	.9815	.9967	.9367	.9400
17	1.0000	.9980	.9271	.9266
18	1.0000	.9998	1.0711	1.0694
19	1.0000	.9991	.7459	.9990
20	.1417	.1535	.6388	.6465
21	.2818	.2073	.7661	.7419
22	.2432	.3289	.7525	.7874
23	.2813	.3481	.6110	.6338
24	.3429	.5375	.7790	.8314
25	.3333	.6931	.8452	.9435
26	.2833	.5206	.6500	.7401
27	.4500	.5423	.6786	.7151
28	.2143	.6218	.7111	.8515
29	.1667	.6522	.8149	.9348
30	.1558	.5260	.3873	.6666

Table E-1 (Continued)

	Retention		Continuation	
LOS	Actual	Predicted	Actual	Predicted
		Occupational Group 9		
1	.0000	.6857	5.0369	5.0120
2	.3659	.6954	1.0036	1.0120
3	.5826	.6892	.9470	.9552
4	.6379	.6720	.7487	.7699
5	.7264	.7390	.8950	.8991
6	.1523	.2038	.6823	.7016
7	.2865	.2791	.9158	.9143
8	.5540	.4073	.9242	.8876
9	.6807	.5939	.8740	.8441
10	.7267	.7521	.8499	.8583
11	.7109	.8624	.9069	.9327
12	.8558	.9290	1.0003	1.0130
13	.8957	.9608	.9758	.9894
14	.9211	.9798	.9460	.9572
15	.9417	.9875	.9490	.9587
16	.9697	.9921	1.0352	1.0386
17	.9583	.9956	.9369	.9414
18	1.0000	.9957	.9594	.9591
19	.9412	.9970	.8437	.9602
20	.1262	.1273	.6455	.6470
21	.3201	.1220	.5906	.5465
22	.2143	.3495	.7248	.7866
23	.2500	.4377	.6953	.7414
24	.2455	.6621	.5217	.7661
25	.8333	.9038	1.0209	1.0339
26	.2083	.7359	.6528	.9023
27	.0000	.8063	.7334	.8592
28	.6667	.8766	.9167	1.0302
29	.0000	.9024	.6250	1.0762
30	.1667	.7195	.5222	.7988

Table E-2

Mean Absolute Error (MAE) in Predicted Retention and Continuation Rates for Occupational Groups Under Current System

Occupational Group	MAE in Predicted Retention Rate	MAE in Predicted Continuation Rate
1	.0362	.0466
2	.0529	.0175
3	.0355	.0103
4	.0460	.0231
5	.0434	.0160
6	.0543	.0270
7	.0606	.0178
8	.0536	.0253
9	.0670	.0199
10	.0521	.0150
11	.0345	.0139
12	.0447	.0177
13	.0304	.0208
14	.0396	.0143
15	.0467	.0522

Note. The mean absolute error is weighted by the number of deciders in each LOS cell.

APPENDIX F

CONTINUATION RATES UNDER CURRENT AND SECDEF RETIREMENT SYSTEMS FOR GROUPS 1, 2, 6, AND 9

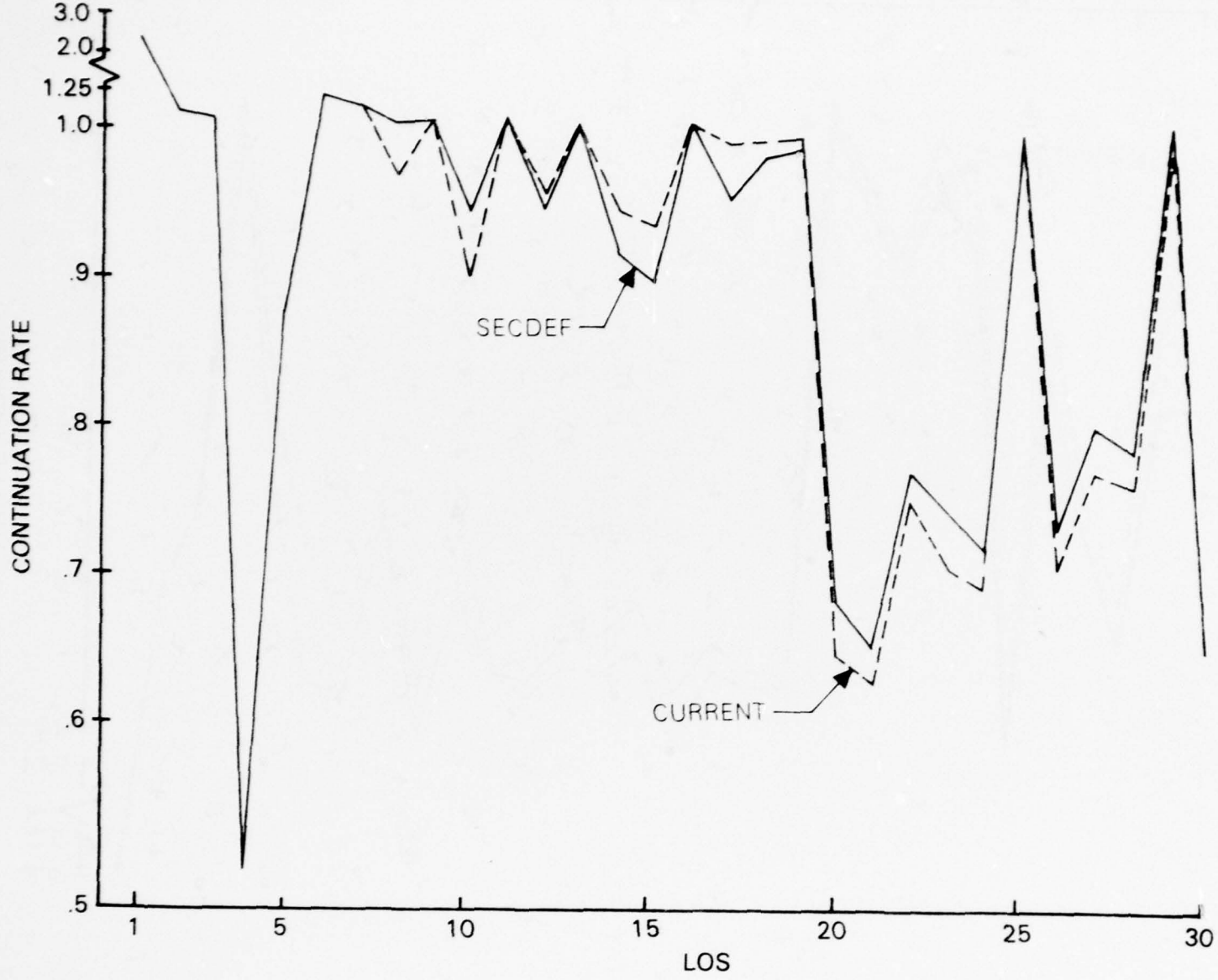


Figure F-1. Continuation rates for Occupational Group 1 (Ship Operations) under current and SECDEF retirement systems.

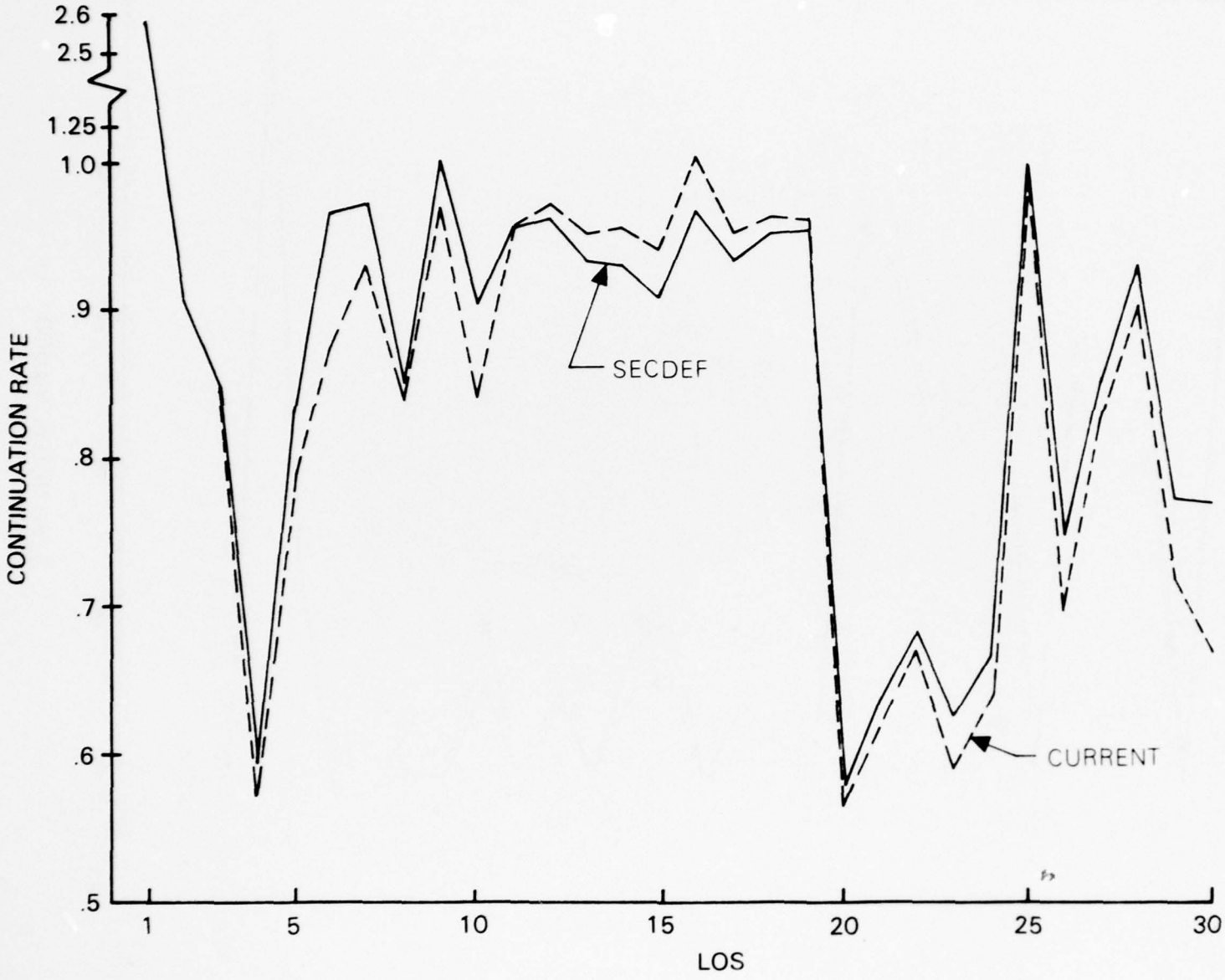


Figure F-2. Continuation rates for Occupational Groups 2 (Marine Engineering) under current and SECDEF retirement systems.

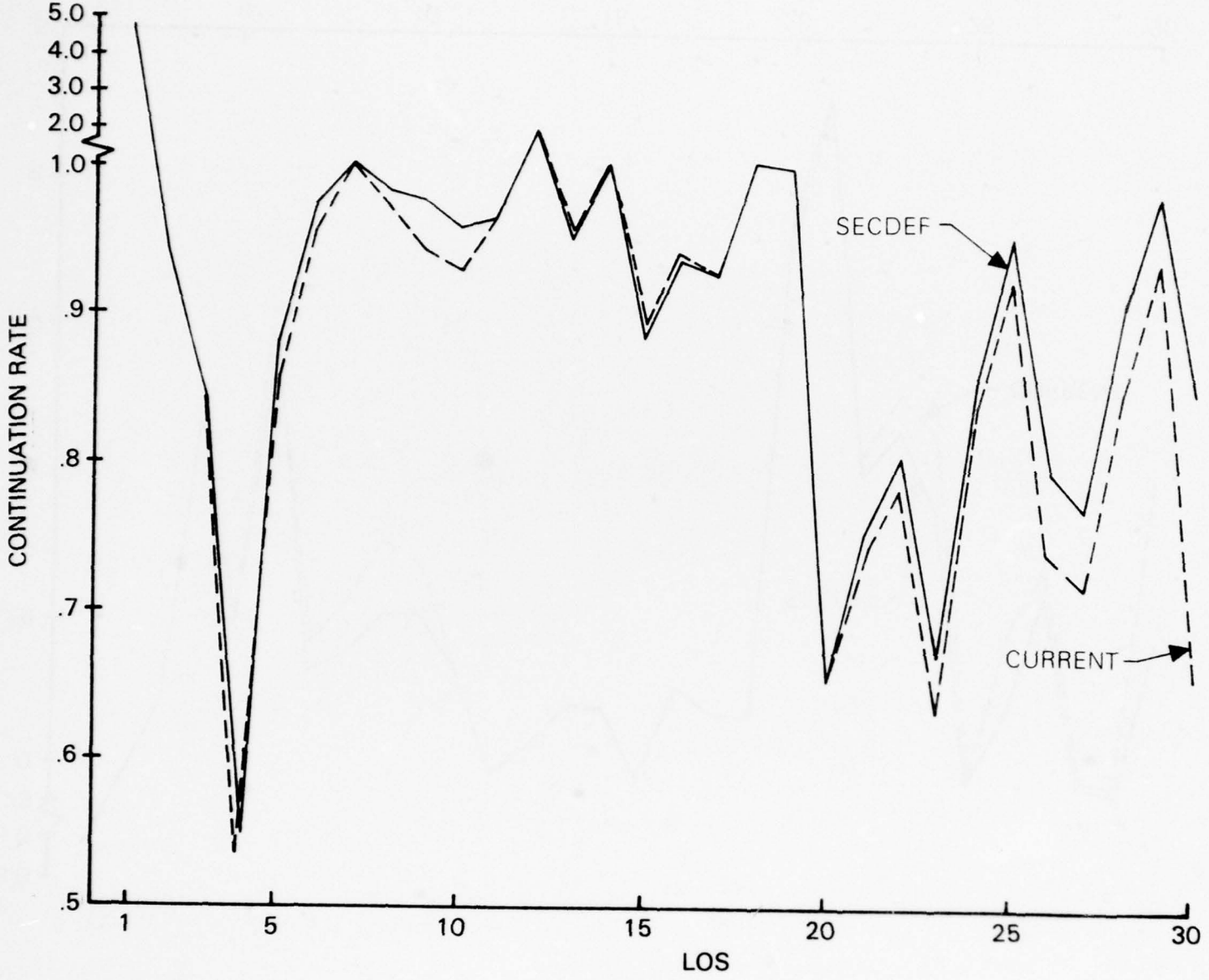


Figure F-3. Continuation rates for Occupational Group 6 (Aviation Operations/Control) under current and SECDEF retirement systems.

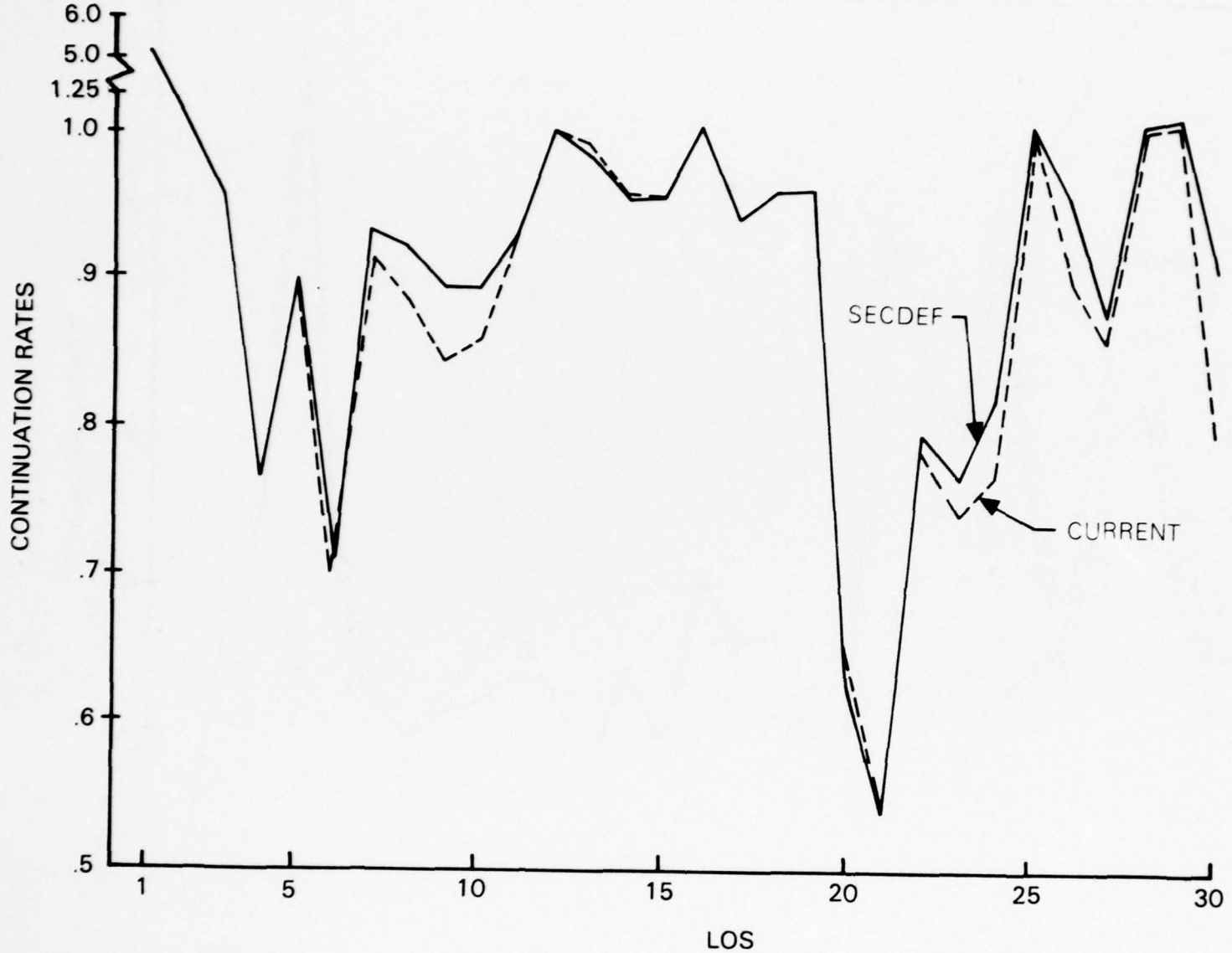


Figure F-4. Continuation rates for Occupational Group 9 (Sensor Operations) under current and SECDEF retirement systems.

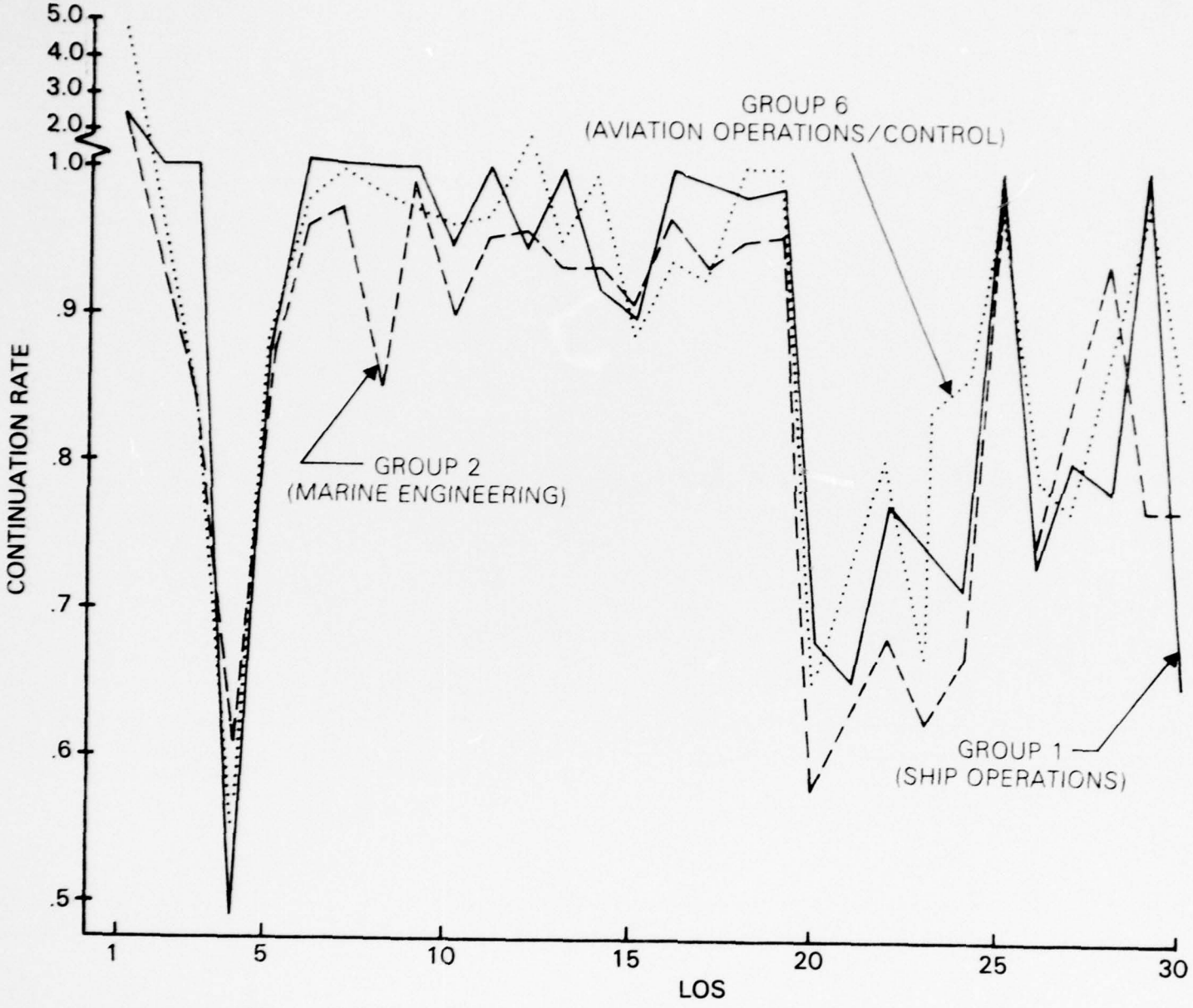


Figure F-5. Continuation rates for Occupational Groups 1, 2, and 6 under SECDEF retirement system.

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